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● Good from the grass roots down! You can't set casing too deep for HOWCO Floating and Guiding Equipment. 100% successful performance in the difficult casing territory below 9,000 feet. ● In each case, the result was the same: casing guided and floated successfully ... no interference with establishing circulation ... easy flow of thousands of sacks of cement through float valves ... valves and guides drilled out easily. ● Halliburton entered the field of floating equipment so that it might have greater assurance of successfully completing your deep cementing jobs. The 100% record fully justifies our decision.
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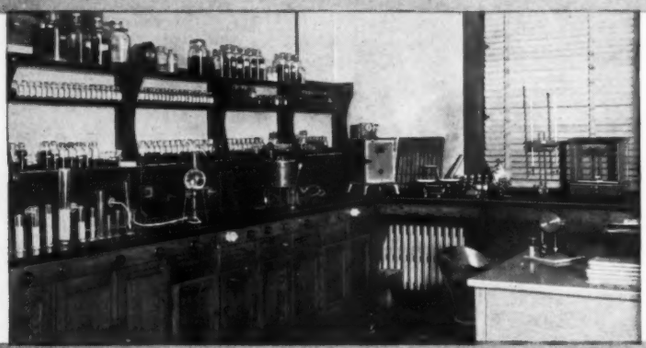

and developer of the most economical processes of treating crude oil to pipe line requirements.

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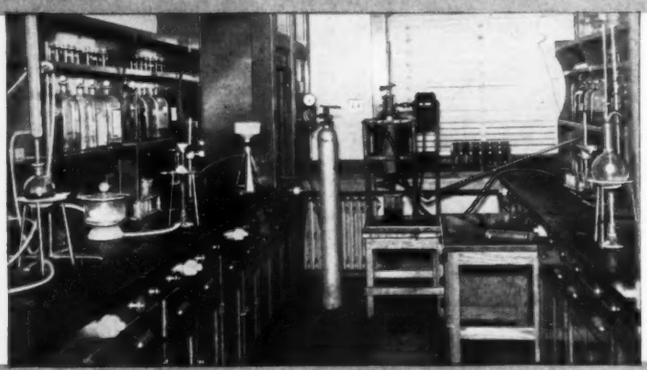

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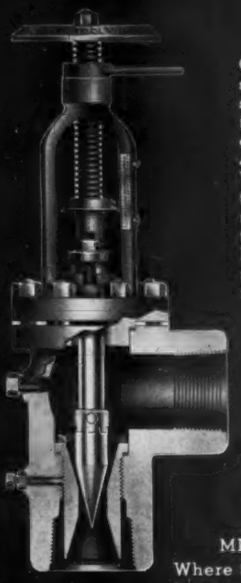
Proration of production can be secured most accurately by using Shaffer Adjustable Flow Beans. Their unique design makes them superior for controlling the flow of fluid and providing means of regulating the pressure and rate of flow to the closest degree possible. A tapered orifice is employed through which is moved a tip to form a needle valve. This adjustable feature provides the correct size of opening without breaking the flow of oil or gas. As the orifice is designed on the principle of the Venturi tube, it allows fluid to flow through smoothly and with minimum turbulence or tendency to emulsify. Consequently a greater volume of fluid will pass through an orifice of given area in this bean than through the same area in other makes.

Shaffer Adjustable Flow Beans are used extensively for holding back pressure on circulation fluid during drilling. They are particularly adaptable as mud valves and work better under high pressure than ordinary valves or stop cocks. Operators are using an extra Shaffer Adjustable Flow Bean on Christmas tree flow lines for a complete shut-off instead of a gate valve or stop cock. Write for the 1936 Shaffer Catalog or see the Shaffer Section in the Composite Catalog.

SHAFFER TOOL WORKS

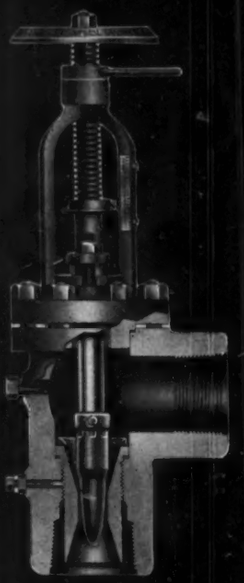
BREA, CALIFORNIA HOUSTON, TEXAS

EXPORT: OIL WELL SUPPLY COMPANY



TYPE 34

Our latest design made for pressures up to 5000 pounds per square inch. The yoke assembly is bolted to the tee and makes it easy to remove without throwing a strain on the connections. The Venturi tube is screwed into the tee with a wrench and can be removed without disconnecting the tee from the flow lines. The tip is locked on the end of the stem by means of a pin and inter-locking nut.



MICRO TIP

Where it is desirable to secure an equal increase in opening area for each turn or fraction of turn of the wheel throughout the entire travel of the tip Shaffer Adjustable Flow Beans can be furnished with Micro Tips. With the Micro Tips any movement of the wheel will increase or decrease the flow area the same amount at the beginning, in the middle or at the end or in fact any point in the travel of the tip. The construction of the flow bean except for the shape of the tip is the same as type 34.

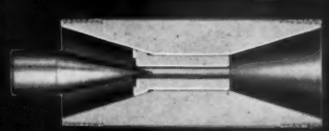
EAST TEXAS TYPE

Designed to control the flow of moderate pressure wells without sacrificing any of the flowing qualities found in the high pressure types. The materials used in its construction are carefully selected for the special requirements.

The Venturi tube insert is easily removed for replacement or for swabbing by unscrewing the yoke assembly from the tee.

TYPE 27

The original design of Shaffer Adjustable Flow Beans and beans of this type are widely used in oil fields all over the world. Internal construction and operation are the same as the Type 34. The yoke is screwed into the tee. The Venturi tube is made from solid rolled steel. The tee is a drop forging. Made for pressures up to 5000 pounds per square inch.

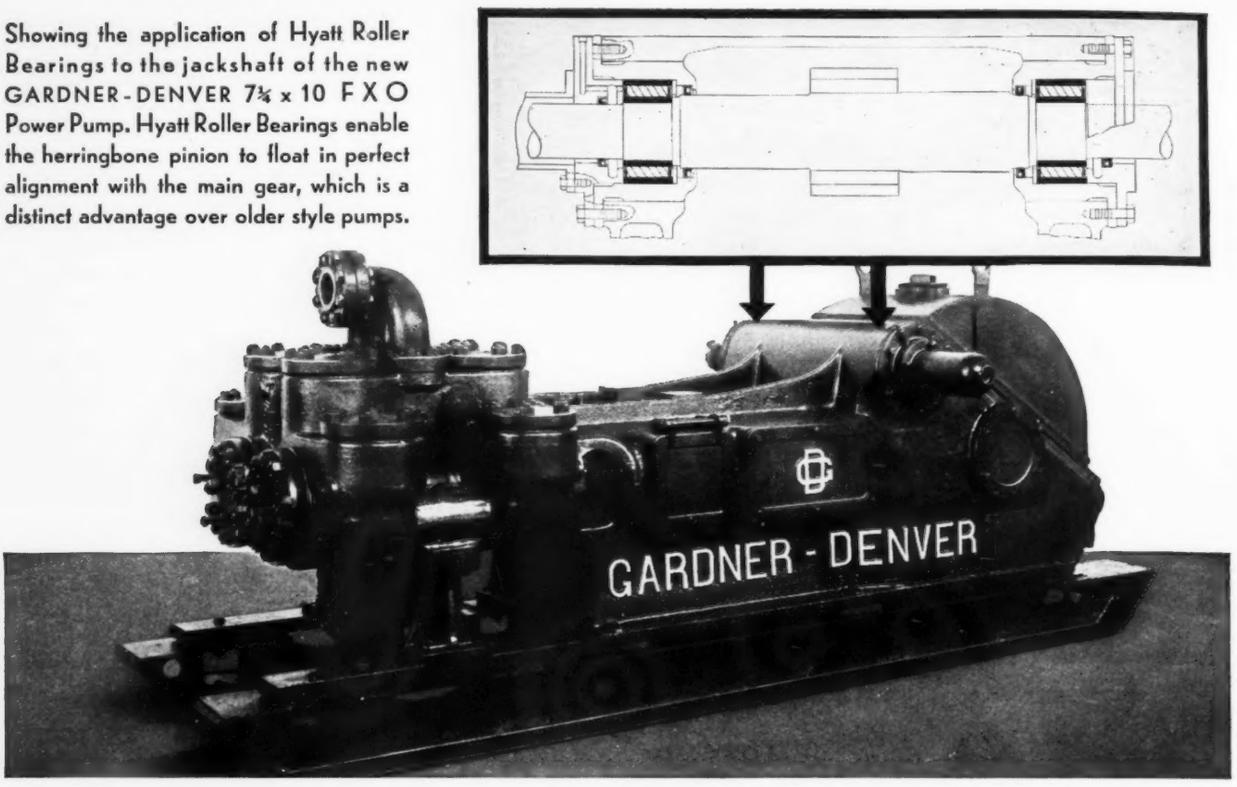


REPLACEABLE BUSHING FOR PRESSURE DRILLING

In order to economically counteract high abrasive action, especially when the Flow Bean is used to hold back-pressure on the mud system when drilling under pressure, replaceable bushings can be furnished.

The seat for the tip in these bushings is provided with hard-faced metal to resist cutting action of sand or other abrasives.

Showing the application of Hyatt Roller Bearings to the jackshaft of the new GARDNER-DENVER 7¼ x 10 F X O Power Pump. Hyatt Roller Bearings enable the herringbone pinion to float in perfect alignment with the main gear, which is a distinct advantage over older style pumps.



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Hyatt's service to industry goes far beyond the meeting of mere specifications. It lies in constructive help to designers, manufacturers, and engineers . . . in new ideas, new products, new ways of doing things.

And wherever Hyatt Roller Bearings are employed, you can count on the saving of all possible power, lubricant, and operating costs. But this is just the beginning of Hyatt economy. Long after being completely written off, Hyatt-equipped machinery continues its better, low-cost production.

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H Y A T T

ROLLER BEARINGS

PRODUCT OF GENERAL MOTORS

The Petroleum Engineer, issued thirteen times a year by the Petroleum Engineer Publishing Co., 405-409 Tower Petroleum Bldg., Dallas, Texas. Subscription price, $1.00 per year, except in Canada, where the price is $1.65 per year—15 cents a copy. Entered as second-class matter May 1, 1932, at the post office at Dallas, Texas, under the Act of March 3, 1879.

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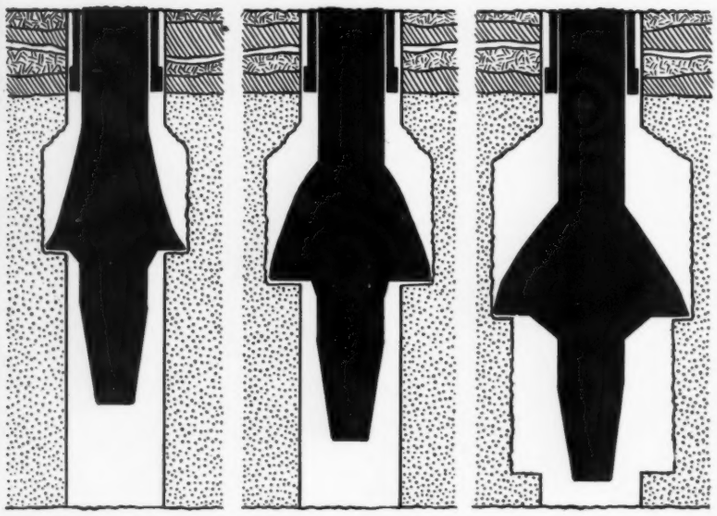
Of their

ROE "THE" UNDERDIGGER

FOR GREATER OIL RECOVERY from New and Old Wells

HOW IT OPERATES



1 2 3

1—A special set of "starting cutters" are used to open the hole below the casing. These cutters are designed to dig their way into the walls of the hole forming the shoulder on which the underdigging operation is started. *This shoulder may be made at any point desired below the casing.*

2—After the shoulder has been made, the "starting cutters" are replaced by a set of underdigging cutters, and the operation of increasing the diameter of the hole is then carried to the bottom, or to any point desired, of the hole.

3—Enlargement of the hole is governed by the size of the underdigging cutters used. In reconditioning old wells, the walls of the "pay" formation may be cleaned and the diameter of the hole increased at several succeeding operations as little as one inch at a time, or the maximum enlargement of more than double the drilled diameter of hole may be made by using only the No. 2 and No. 3 underdigging cutters.

Ordinarily only three sets of cutters (furnished with each sale or rental tool) are required: No. 1, "starting cutters"; No. 2 underdigging cutters enlarge the diameter of the hole approximately 50%; and No. 3 underdigging cutters increase the diameter of the hole approximately double its original size.

Initial production of both rotary and cable tool drilled wells may be increased through use of the Roe "Pay" Underdigger by removing mud, cement and other accumulations from the face of the "pay" to facilitate the free flow of oil into the hole.

Initial production in wells with "tight" formations that have been "shot" one or more times may be increased through use of the Roe "Pay" Underdigger by removing that part of the formation that has been glazed and closed by the heat of the "shot."

Initial production in "lime" wells may be increased through use of the Roe "Pay" Underdigger by enlarging the "pay" formation area to more than double its drilled size that the chemicals used in acidizing may contact a greater wall area.

Production in old "sand", "lime" or "shale" wells may be increased through the use of the Roe "Pay" Underdigger by removing paraffin, gypsum, salt, mud and other obstructions from the walls of the formation for the free flow of oil into the hole. If desired a reservoir more than double the drilled size of the hole may be formed at any point in the "pay" formation. *The Roe "Pay" Underdigger has increased production from 15% to over 200% on many wells during the past two years. Results have been outstanding on 95% of the wells on which it has been used.*

U. S. Patent No. 2012775

SIMPLICITY OF OPERATION

Any practical driller, who observes the simple operating instructions furnished with the Roe "Pay" Underdigger, can run it and do a good job without previous experience. Powerful and rugged, with only six parts including the two cutters, it runs in and pulls out of the pipe as smoothly as a string of tools and even under adverse conditions there is practically no danger of leaving any part of the tool in the hole.

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This photograph was taken near the birthplace of the world's first big oil field, a few miles from Limestone, New York. In 1868 Job Moses drilled a well near Limestone which produced some oil. Little was done in the area, however, until the Butts Well below Tarport proved the real beginning of the Bradford Field. The early development of this famous field was confined to the Tuna Valley between Bradford and Limestone.

While somewhat late in being introduced in the Bradford Field, UNION Wire Lines are rapidly becoming popular in this field. This great field, still a big producer after 68 years,—and UNION Lines,—have one thing in common—amazing endurance. UNION Lines are designed especially for extra endurance under oil field conditions.

The photograph was taken on a Nichols Run Oil Company lease. The men, left to right, are: E. L. Wells, teamster; K. O. Bickell, roustabout; L. D. Fargo, roustabout; R. B. Conrad, tool dresser; J. E. Humphrey, Union Wire Rope Corp.; C. L. Pfouts, driller; H. W. Murray and Jack Ainsworth, of the Keystone Driller Co.

THE AMAZING RECORD of the BRADFORD FIELD

The world's first BIG oil field.

Peak production, 1881, was 23,000,000 barrels, 77% of world production that year.

In this, its 68th year, will produce approximately 13,000,000 barrels of oil.

Of more than 21,000 wells drilled in this field, only about 5% were unremunerative.

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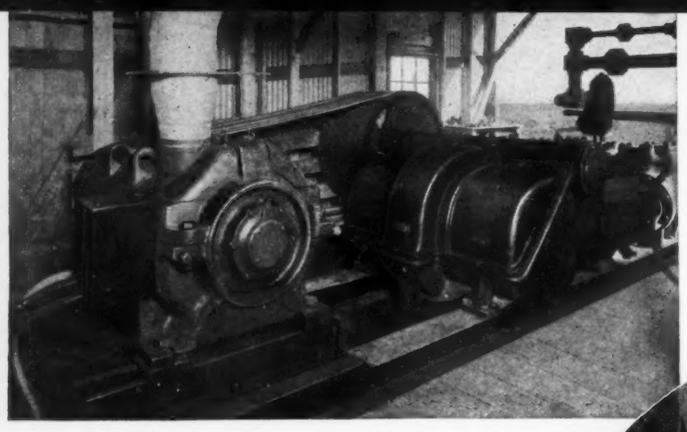
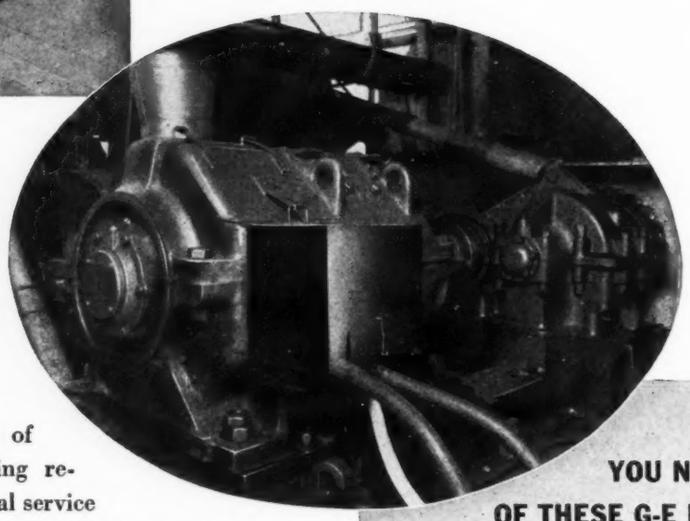
UNION WIRE LINES

The "ULTIMATE LOW COST WIRE ROPE"



How G-E D-c Drives for Rotary Rigs Can Save You Money



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When you buy G-E drives, you buy high-quality equipment — backed by records of outstanding economy — and the technical advice and co-operation of the G-E organization. For information concerning complete oil-industry electric equipment, write the G-E sales office nearest you, or to General Electric, Schenectady, New York.

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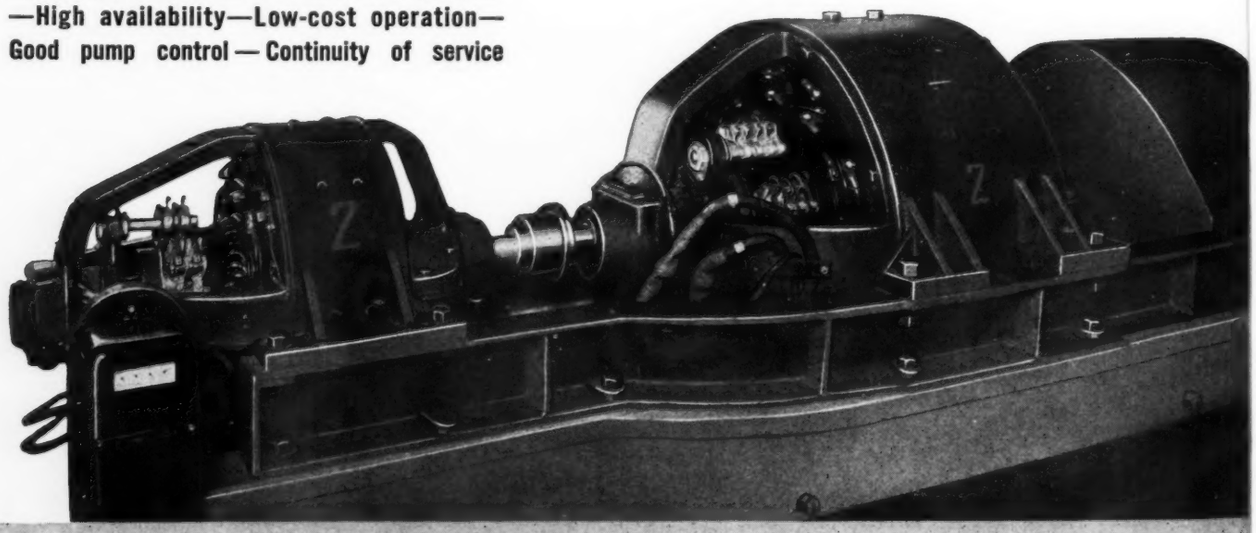
Engine-overload prevention — High hook speed — High availability — Low-cost operation — Good pump control — Continuity of service



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THAT LAST LONGER

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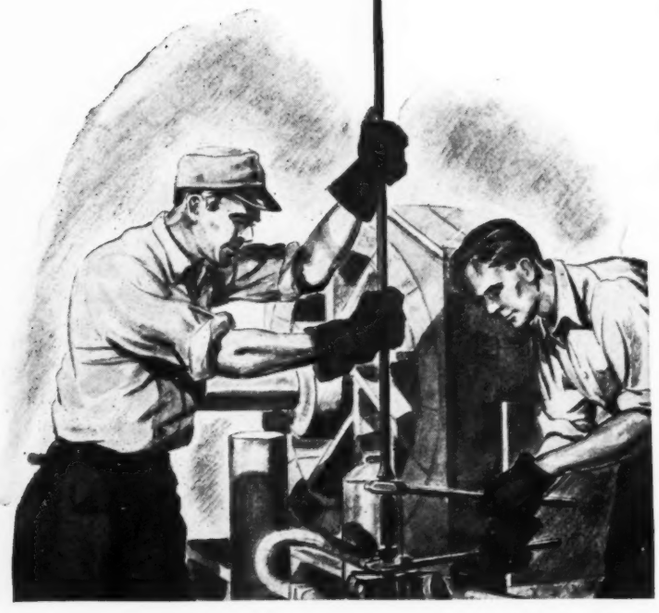

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IN THE TOUGHEST FORMATIONS
with this ELLIOTT
HARD FORMATION
Cutter Head!

Proved in service for more than a year—in the hardest rock formations, under the most severe conditions—this Elliott Hard Formation Cutter Head marks another important development in coring equipment by Elliott engineers. Simply, ruggedly built for the toughest coring, this tool comes to the attention of the industry with many decided advancements in design and construction—and a reputation for withstanding abusive wear without leaving anything in the hole.

Roller cutters, mounted on ball bearings and arranged so as to divide the wear evenly, assure smoother co-ordination and long life to the complete assembly. These cutters do not run in pockets, but are open to the circulating fluid over their entire surface—a feature which, combined with the ball bearings, results in positive, free-rolling action with no tendency to jam, ball-up or slide.

In actual service this Elliott Hard Formation Cutter Head, interchangeable with Elliott Soft Formation Cutter Heads, has set new records in high recovery, footage, and number of runs without rebuilding or replacement.

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Elliott Rotary Core Drill with Soft Formation Cutter Head

The Elliott Hard Formation Cutter Head

Bottom View, Elliott Hard Formation Cutter Head

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Companion to 80" Traveling Block.

All sheaves and bearings interchangeable.

300-ton capacity—new arched truss member equalizes load, overcomes side drag and prevents twisting and tangling of lines—convenient auxiliary sheaves for catline, sand line, (Mid Continent or California types) and dead line for dual hoist rigs—roller bearings, pressure lubricated —simple, compact, easily installed —operates easily at high speeds and heavy loads.

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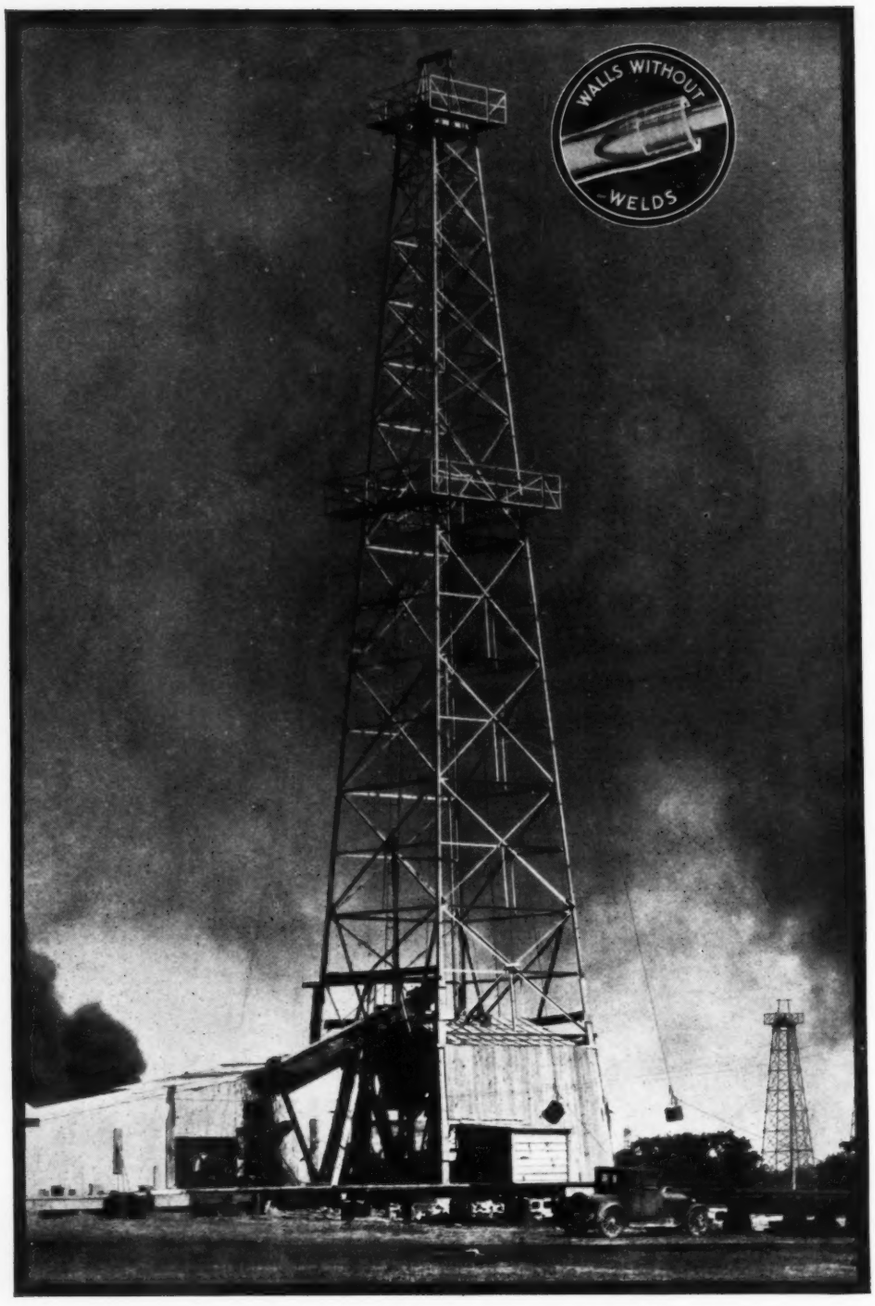

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Extra strength and security where most needed are given by the heavy upset ends in addition to a correct balance of metal against stress for every demand of service. The extra thickness at the ends affords abundant wearing metal, forces any bending away from the joints and gives increased resistance to the crushing action of the coupling—an important safe-guard where tubing is to be made up and broken down time after time. Galvanized NATIONAL A. P. I. Seamless Tubing is available for your corrosive conditions. Specify NATIONAL A. P. I. Seamless Tubing for your wells.

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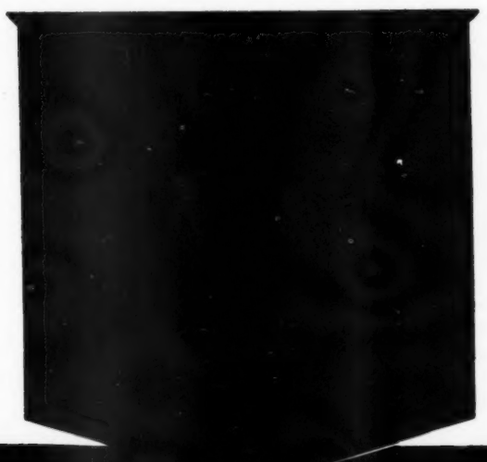
UNITED STATES STEEL

INTERNATIONAL PETROLEUM EXPOSITION

TULSA May 16-23, 1936



Knowing the world-wide importance of the far reaching improvements and advancement made during the past two years, and recalling the great practical and educational value of its previous expositions, the world leaders in the petroleum industry are preparing to attend the Ninth International Petroleum Exposition when it opens in Tulsa in May.

Executives, engineers, superintendents, purchasing agents and other key men in all branches of the petroleum industry, are planning to attend. Manufacturers and distributors of equipment, material and supplies are assembling their greatest exhibition. Societies, Associations, Bureaus and Departments are planning exhibits, demonstrations and meetings.

On May 16th the world's greatest industrial exposition will open its doors to the largest attendance in its history.

Phone, wire or write for complete information, to—

WM. B. WAY, General Manager

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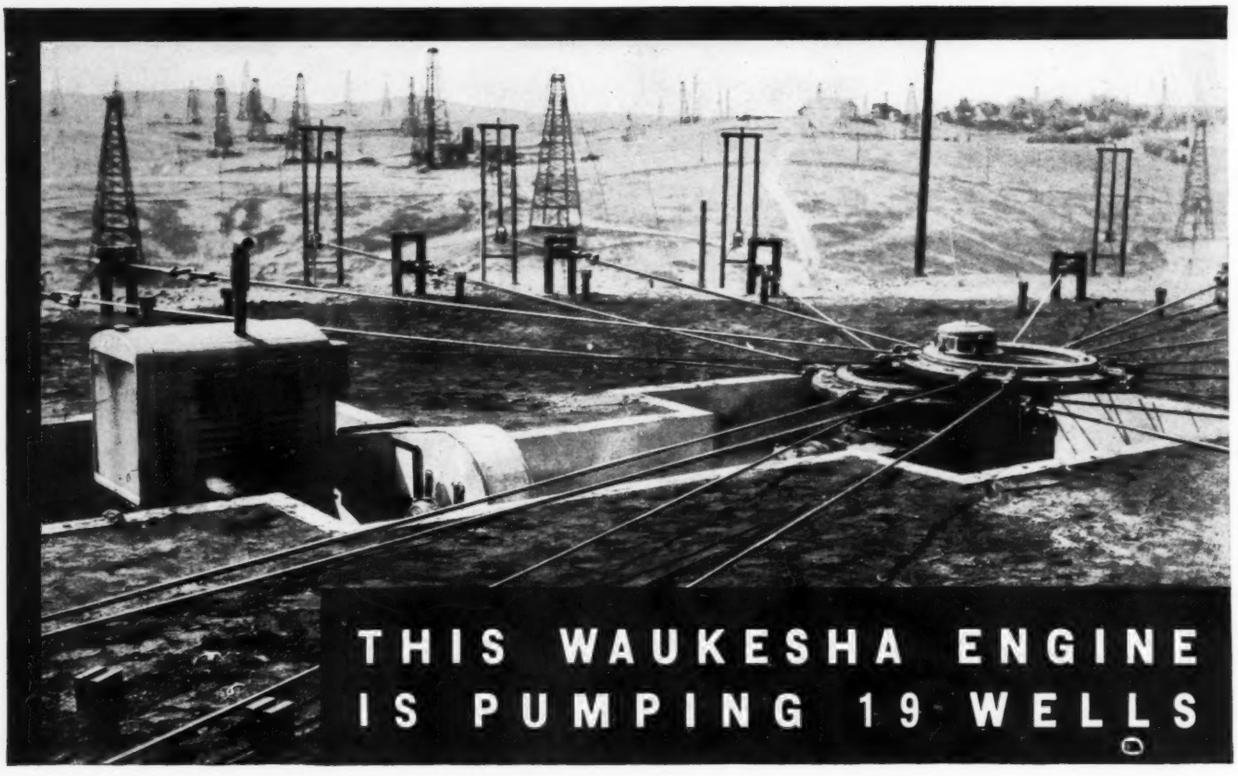
The World's Fair of the Oil Industry



On the Missouri Lease of the Associated Oil Company, in the old Kern Field near Bakersfield, California, this 35-45 hp. VIKU Waukesha Pumping Engine is driving an Oil Well Supply Company No. 50 Oilbath Geared Power Installation which is handling nineteen wells, tubed to an average depth of 800 ft., mostly with 3-in. tubing. And, in addition, the same power unit handles three jack pumps, used for collecting oil from a sump and transporting it to distant reservoirs.

The oil is 14° gravity and gross production about 1200 barrels a day; 10 to 20 per cent is oil, the rest water. The pumping power operates at from eight to ten strokes per minute. It takes a Waukesha Engine to do a pumping job like this!

Originally the engine operated on fuel gas obtained from the lease. At present it is running on purchased fuel costing thirty cents per thousand cu. ft. With a fuel consumption of 12,000 cu. ft. daily, the per diem fuel cost is $3.60. The engine operates at 1100 rpm with a V-belt drive from the reduction gear on the crankcase to an extended pinion drive from the power, total reduction being approximately 110-1.

Waukesha Oil Well Pumping Engines range in size from 15 hp. up. *Write* for Bulletin 970. *Waukesha Motor Company, Waukesha, Wisconsin.*

WAUKESHA ENGINES

THE Petroleum Engineer

FEBRUARY 1936 VOLUME VII NUMBER V

A MAGAZINE OF METHODS FOR OPERATING MEN

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Meetings

California Natural Gasoline Association—March 5, Richfield Building, Los Angeles.

Mid-Continent District Petroleum Division of A.P.I., Spring Meeting—February 20 and 21, Wichita, Kansas.

Western Petroleum Refiners Association, Annual Meeting—April 9 and 10, Excelsior Springs, Missouri.

American Petroleum Institute, Division of Production, Southwestern District—April 9 and 10, Washington-Youree, Shreveport, Louisiana.

Petroleum Industry Electrical Association—April 11, 12, and 13, Tulsa, Oklahoma.

Pacific Coast District, Division of Production, American Petroleum Institute, Spring Meeting—April 14, Los Angeles, California.

Oil Equipment and Engineering Exposition—April 20, 21, 22, 23, 24, and 25, Houston, Texas.

Natural Gasoline Association of America, Annual Meeting—May 13, 14, and 15, Mayo Hotel, Tulsa, Oklahoma.

American Petroleum Institute, Mid-Year Meeting—May 13, 14, and 15, Tulsa, Oklahoma.

International Petroleum Exposition—May 16-23, Tulsa, Oklahoma.

Independent Petroleum Association of America, Mid-Year Meeting—May 21, Tulsa, Oklahoma.

American Society of Mechanical Engineers, Semi-Annual Meeting—June 15, 16, 17, 18, 19, and 20, Dallas, Texas.

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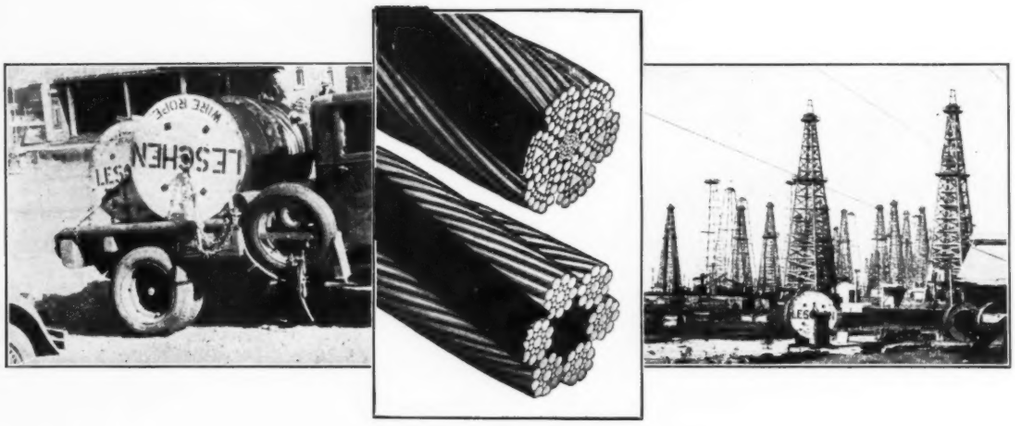

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The Course of Oil

By K. C. SCLATER

Allocation of Production The problems arising from present curtailed production are many but in general fall into two major categories which are definitely related, yet are influenced by different factors. Under the petroleum code State quotas were specified and comparative allocations between fields were made later to give each field what was determined to be its fair share of the limited market demand of the State. * * * The engineering factors of a pool were requisite in determining the percentage of a State quota allowed to any pool during a given period, but the determined rate of withdrawal from the pool as a whole frequently has been the result of balancing factors of economic expediency against what the field could produce on account of its physical characteristics. There is reason to believe that some fields have been produced under prorated conditions at a rate lower than that dictated by the best engineering principles. However, in those fields where the pressure in the reservoir has been maintained and the energy conserved the main general effect of restricted production on a pool is retardation of the time of maturity in recovering the ultimate extractable oil. * * *

The allocation of production from the field quota to individual wells or properties, in an attempt to assure "ratable taking" to each well in a common pool, differs substantially from the foregoing conditions pertaining to State and field allocations. There is immediate concern by the property owners and leaseholders, not only because the present worth of the oil is influenced by the rate of extraction but the actual quantity that may be taken from the wells of individual properties may be affected in large measure by the comparative rates of production on the several adjacent tracts. * * *

The completely personal interest of an operator is centered primarily in (1) the quantity of oil and gas his well or wells are capable of producing under a set of conditions during a specified period of time and (2) the ratio between his quantity and the quantity he will be permitted to produce in accordance with the proration plan applying to his properties. This set of conditions led to the practice of taking well "potentials" in an effort to reach a basis for estimating the quantity of allowed production for individual wells throughout a given period.

Of all restrictive terms the word "potential" probably has been used more loosely and with more detrimental effect than any of the others. The mere statement that a well, tract, or field has a "potential" of a given number of barrels means little or nothing in relation to the capacity to produce — and the continuance of that established rate of production. "Potential" has been defined as "the rate at which a well will produce oil under any standard test conditions" and "open-flow potential" as "the rate at which a well will produce oil with atmospheric pressure at the well head"; but the full implications of these definitions must be realized. Reservoir conditions change rapidly when and after wells are flowed to make capacity-production tests; the status of adjacent wells or tracts influences the results of potential tests; and the mechanical conditions of wells appreciably affect the results. The potential method has been used extensively, but many erroneous figures have been established. In consequence, not only has production in a field been allocated inequitably, but field potentials have been raised to fictitious and impossible quantities. * * *

Fortunately, the realization is growing that inflated potentials result in the uneconomic practices named as well as many others that cause unnecessarily rapid depletion of oil reserves and financial loss. Commendable progress has been made in working out scientific principles for allocating production—not on the basis of what a well can be made to flow in a specified number of hours with its adjacent wells closed, but rather by determining the comparative abilities of wells to produce efficiently with an optimum use of reservoir energy, through applying knowledge of reservoir and well performance.

The term "productivity index" is now being used extensively by engineers to indicate the measure of a well's capacity to produce. * * *

The use of an allocation formula which includes a productivity index or measure of the capacity of a well to produce oil and gas from the reservoir is a special application of the principles which have evolved from studies dealing with the control and operation of gas wells conducted by the Bureau of Mines in coöperation with the Natural-Gas Department of the American Gas Association. The efficacy and practicability of the so-called "back-pressure method" of gaging the capacities of gas wells to produce gas, supplanting the outmoded open-flow tests, have been proved, and it has been pointed out that the same fundamental relations in the reservoir and flow columns of gas wells, given in two Bureau of Mines reports published in 1929, and in a more complete report on the subject in preparation, are applicable to reservoirs containing oil and gas mixtures if suitable modifications are made to the basic equations pertaining to the flow of natural gas. * * *

A very important problem of stabilization during this period of production control is whether allocation formulas are to be shaped to conform with existing legal opinions or whether our laws, especially their interpretation, may be made to conform more nearly with known physical conditions in the reservoirs.

The foregoing pertinent discussion on allocation of production is an excerpt from the Minerals Yearbook, 1935, published by the U. S. Bureau of Mines. The title of the chapter in which the discussion appears is "Influence of Petroleum Technology Upon Composite Interest in Oil," and was written by H. C. Fowler and R. A. Cattell of the Bureau of Mines staff at Washington, District of Columbia.

» » » HIGHLIGHTS IN OILDOM » » »

Percentage Flowing Wells Increases

According to the monthly report of the Texas Railroad Commission, at the beginning of the year the state had 23,349 flowing wells and 36,112 pumping wells, a total of 59,461. At the beginning of 1935 there were 19,277 flowing and 33,294 pumping wells in the state. Pumping wells thus comprised 63.3 percent of the total number producing. At the start of 1936, however, the percentage of pumping wells had declined to 60.7, although the number had increased 2,818. Flowing wells increased 4,072 during the same period. This gain in percentage of flowing wells is due to the predominance of the East Texas field, where there were but 1,950 pumping wells out of a total 19,463 in the area.

●

May Test To Determine Water Level

Test wells may be drilled in the East Texas field to determine the water level in the area, according to recent reports. Engineers are somewhat in the dark as to exactly where the water level is, due to the fact that so little oil is being taken from the wells, and it is thought there may be some with brine in the bottom but still not revealing traces of it. One authority, who is thoroughly familiar with conditions in the field, states that in his opinion the water level is rising with remarkable uniformity, although slowly. Bottom-hole samples have been taken recently in approximately 300 wells, he says, and salt water was found only in those that had been drilled below the present water table.

If the test wells are drilled they will be cored entirely through the producing horizon, casing cemented, and the pipe perforated at the producing formation. It is believed this will reveal the true water situation.

●

Expect Increase In Carload Shipments

Thirteen regional advisory boards estimate that during the first quarter of 1936 carload lot shipments of crude oil and petroleum products will increase by 4.2 percent. During 1934, the last year for which complete data are available, 55,776,394 tons of petroleum freight originated on class one railroads and produced freight revenue totaling $243,156,205, nearly ten percent of all carload freight revenue received by rail carriers during the year, according to the Interstate Commerce Commission.

●

Kansas Crude Potential At Peak

A report issued by T. A. Morgan, director of the conservation division of the Kansas Corporation Commission, shows potential production of Kansas oil fields to have reached an all-time peak. The state's 19,635 wells have a potential of 957,504 bbl., and it is predicted by proration officials that this figure will pass the million-barrel mark by March 1st for the first time in history.

●

Mexican Oil Output Up In 1935

Mexico's 1935 oil production amounted to approximately 40,234,725 bbl., valued at $40,000,000, a report by the petroleum department of the Ministry of National Economy shows. This production is the greatest since 1929 when the output was 44,687,879 barrels.

Of the 1935 production, 29,754,152 bbl. were light crude, and 10,480,573 bbl. heavy crude. The most prolific producing area last year was the Tuxpan, yielding 19,447,189 bbl. of light crude, and the Tampico fields were runners up with 10,480,573 bbl. of heavy crude. The Isthmus of Tehuantepec had an output of 10,306,963 bbl. of light crude.

●

Request Oil Import Tax Increase

A bill has been introduced in congress by Representative Wesley E. Disney, of Tulsa, Oklahoma, providing for an increase in excise taxes on oil imports and limitation of importations to 4½ percent of the domestic consumptive demand.

The bill asks that taxes on imported crude, fuel and gas oil be increased from one-half cent to one cent a gallon, and that a new tax of $2.00 per ton be levied against imported asphalt.

"Millions of dollars will be diverted from the foreign to the domestic petroleum industry," Disney said, "increasing the wages received by labor and the purchasing power of nearly half the states of the Union, without imposing burdens on the consumer, if congress passes this bill. Imported petroleum has been taking a very considerable portion of the domestic market to the harm of the home industry and to the detriment of our employment program."

Because of its tax features, the bill was referred to the House Ways and Means Committee instead of to the Interstate Commerce Commission, which has considered almost all other proposals affecting the Nation's oil supply.

The legislation carried the indorsement of the Independent Petroleum Association of America.

●

Motor Fuel Demand Increasing Says A.P.I. Report

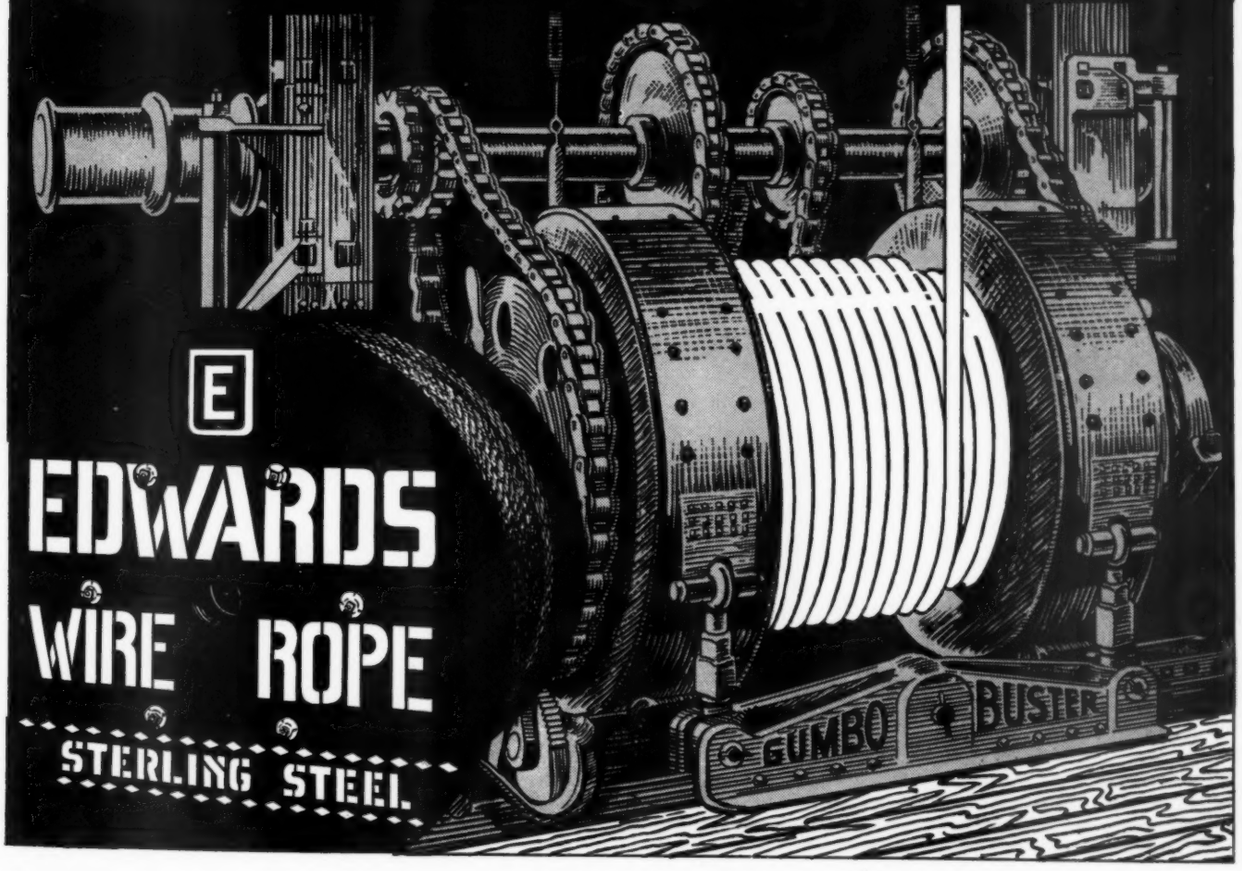
Continued increases both in domestic and export demand for motor fuel and a slight decrease in required domestic production of crude oil are indicated in the first of a series of quarterly reports made by the American Petroleum Institute's Committee on Supply and Demand.

The committee, composed of 15 leading petroleum economists and statisticians appointed by the Institute to report the industry's current statistical position and to estimate immediate future demand for crude oil and motor fuel, placed total demand for motor fuel the first quarter of 1936 at 102,600,000 barrels. Domestic demand is estimated at 95,100,000 bbl., an increase of 8.1 percent, on a daily average basis, as compared with 87,032,000 bbl. shipped during the first quarter of 1935. Export demand is estimated at 7,500,000 bbl., as compared with 5,967,000 bbl. the first quarter of 1935. Total demand for domestic crude oil is estimated at 2,682,000 bbl. daily for the quarter.

The committee placed the total of finished and unfinished gasoline in storage at the end of 1935 at 56,200,000 bbl. as against 52,545,000 bbl. at the end of 1934. The committee expressed belief that the rate of crude oil runs to stills will produce enough fuel oil so as not to impair too seriously the March 31, 1936, inventory position.

Motor fuel demand in 1935 apparently set an all-time record, with shipments totaling 465,200,000 bbl., an increase of 6.9 percent above the 435,000,000 bbl. shipped in 1934. Domestic demand for 1935 was 435,600,000 bbl., an increase of 6.2 per cent over 1934. Exports were approximately 5,000,000 bbl. more than in 1934, the figure for that year being 24,700,000 barrels.

WIRE LINE PERFORMANCE



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PROGRESS OF MAJOR PIPE LINE WORK

THE capacity of the Stanolind Pipe Line Company's trunk line from the Mid-Continent to Whiting, Indiana, is being increased by 10,000 barrels. A total of 86 miles of 12-in. loops and two and one-half miles of 10-in. loops are to be laid in Missouri and Illinois, 50.62 miles of 12-in. in the former state and the remainder in the latter. Officials of the company state that the increased capacity is greater than needed at present, but certain advantages make it desirable to carry out the program as outlined. For one thing it will make possible the transporting of Winkler, Texas, crude without the necessity of batching and without mixing with other crudes.

The entire program is expected to be completed by June 5th.

The Sheehan Pipe Line Construction Company, Tulsa, Oklahoma, has been given the contract for the work in Missouri, and this is now going forward. More favorable weather will be awaited before anything is done in Illinois. H. C. Price, Inc., Bartlesville, Oklahoma, was awarded the contract for welding the loops laid in Missouri.

The location of the loops in Missouri and the mileage are as follows: Freeman, northeast, 9.24 miles; Odessa to Page City Junction, 17.03 miles; Rothville, northeast, 5.38 miles; Ethel, northeast, 7.75 miles; Gibbs to Hurdland Junction, 8.96 miles; Kahoka Junction, southwest, 2.26 miles.

•

Construction work has begun on the laying of two pipe lines for the Continental Oil Company from the Tepetate field, Acadia Parish, Louisiana, to a point northwest of Lake Charles. One line is for oil, the other for gas, and they are being laid in the same ditch. The oil line is 6⅝-in. O.D. and the gas line 8⅝-in. O.D., both approximately 44 miles in length. It is expected that the line will be completed by April 1st. The Apex Construction Company of Houston, Texas, has been awarded the general contract.

A short distance west of Lake Charles a 12-acre site has been acquired for the construction of a terminal. A 500-ft. dock, loading apparatus, two 80,000-bbl. and one 10,000-bbl. storage tanks will comprise the terminal equipment.

In order to hasten the work as much as possible crews are working from either end. Many difficulties are expected to be encountered in the laying of the line, inasmuch as a portion of the right-of-way is through swamps, and it will be necessary also to cross the Calcasieu River, a wide and deep stream.

The gas line will provide Lake Charles with gas for industrial use. The oil line will eliminate a long barge haul.

It is reported also that the Continental Oil Company will erect a casinghead gasoline plant in the Tepetate field. After the gasoline content has been extracted from the wet gas the residue will be boosted through the pipe line outlet for commercial use.

•

Following a consent decree entered into between the government and the Columbia Gas and Electric Corporation, which terminates the Department of Justice's anti-trust suit against the latter, it is announced that plans are being made for the construction of a 300-mile gas line to connect the Panhandle Eastern Pipe Line Company's system with that of the Detroit City Gas Company.

In August of last year the Panhandle Eastern entered into a contract with the Detroit City Gas Company, agreeing to supply gas to domestic and industrial users in that city; however, fulfillment of the contract was delayed by the proceedings of the Department of Justice.

The Panhandle Eastern Pipe Line Company was organized in 1929 as a subsidiary of the Missouri-Kansas Pipe Line Company (Mokan) for the purpose of carrying natural gas from Texas and Kansas to Indianapolis, Indiana, with plans for extending the line to Detroit, Michigan, and to Dayton and Cincinnati, Ohio. In its suit the government charged that Columbia had wrested control of Panhandle Eastern from Mokan and caused Panhandle Eastern to neglect and reject many opportunities to sell its natural gas to prospective customers in Kansas City and St. Louis, in Detroit, and many smaller communities in Missouri and Kansas. The government alleged that by preventing financial aid to Mokan for constructing the Panhandle Eastern line, Columbia obtained an agreement whereby Columbia bought half the stock of the Panhandle Eastern.

The consent decree, signed by Federal Judge John P. Nields of Wilmington, Delaware, ordered the Columbia Gas and Electric Corporation, the Columbia Oil and Gasoline Corporation, and eight individuals, to cease any dominion or control over Panhandle Eastern Pipe Line Company. Gano Dunn, president of the J. G. White Engineering Corporation, was named trustee to hold Columbia's stock in Panhandle Eastern and to exercise any voting rights of such stock in conformity with the decree.

•

The first pipe line outlet for the Withers and Pickett Ridge fields, Wharton County, Texas, is being provided by The Texas Pipe Line Company. Both fields were discovered during 1935 by The Texas Company.

O. G. Whitaker, Inc., has been awarded a contract for laying a combination 4-in. and 6-in. line from the company's pump station in Matagorda County to the fields. The pipe being used is reconditioned stock taken from lines between Powell and Groesbeck, and Conroe and Springs Junction. The line will be approximately 20 miles in length. From Markham to Withers field it will be a 6-in. line, and from Withers to Pickett Ridge a 4-inch. The Withers and Pickett Ridge fields are approximately ten miles apart.

•

D. A. Little, president of the Magnolia Pipe Line Company, announced recently that his company would construct a pipe line to the Rodessa field of Louisiana. The line would extend from Dixie, Louisiana, to Rodessa, a distance of 23 miles, tying into the Magnolia's main line from El Dorado, Arkansas, to Beaumont, Texas. It has not been determined, Little said, whether a 6-in. or an 8-in. line will be laid.

•

The East Texas Oil and Refining Company will lay an 8-in. pipe line from the Rodessa field to Longview, Texas, a distance of 54 miles, it has been announced by Freeman Burford, head of the concern. This will be the fourth pipe line outlet for the field.

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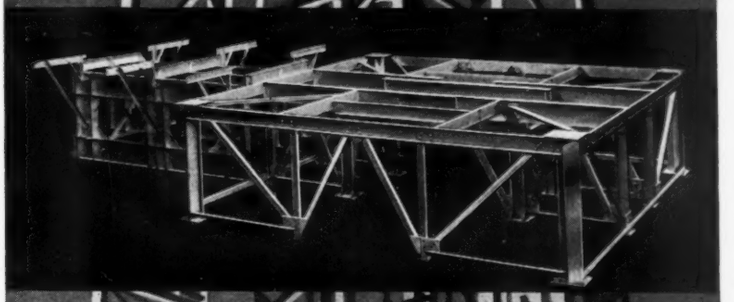

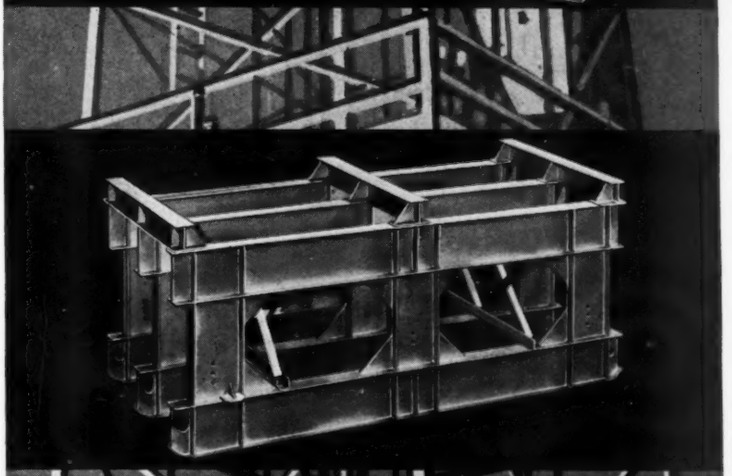

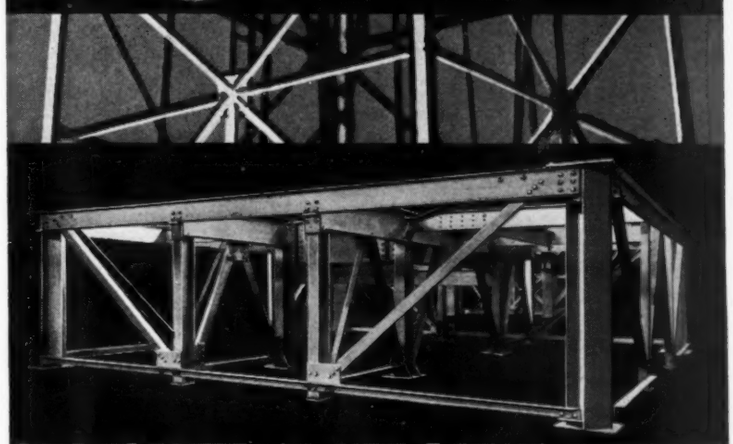

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26'	73'	1,000,000		7,200
30'	73'	1,000,000		8,000
ROTARY SUPPORTS (INTERIOR POSTS AND SILLS ONLY)				
		CASING LBS.	DRILL PIPE LBS.	
24'		300,000	250,000	9,300
26'		300,000	250,000	10,400
26'		500,000	250,000	11,500
30'		500,000	250,000	12,800
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	96"	Heavy		11,000

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LATEST ACTIVITIES IN THE OIL FIELDS

COMPLETION of the Jane Oil Company's No. 1 Gillette, making 25 bbl. of crude hourly at a total depth of 3707 ft., either opens a new pool for Goliad County, Texas, or represents more than a mile extension to the North Pettus pool. As yet operators have not determined its exact status. The well was produced through ¼-in. choke. Pressures were 100 lb. on tubing, and 375 lb. on casing.

●

A new pool for Kansas, the farthest north in that state, has been discovered by F. A. Gillespie and Sons of Tulsa, Oklahoma, and R. E. Hess, of Hutchinson, Kansas. Their well, No. 1 Lowe-Faubian, in Rooks County, seven miles north of Stockton, pumped 60 bbl. on a nine-hour test. Production is from the Oswald lime at a total depth of 3161 feet. The oil is 40 gravity.

●

A new gas field has been opened in the Rio Grande Valley of Texas by John Clopton. His No. 3 Roos and Bennett et al was brought in with an initial flow of 20,000,000 cu. ft. daily through open 2-in. tubing. The well is in Starr County, one mile north of the Rio Grande and six miles west of the Sam Fordyce field. The well was drilled to 4003 ft., and failing to find production, was plugged back to 2650 feet.

●

The Santa Rita Oil Company's No. 1 Sherron, one mile northwest of the nearest production in the Cut Bank, Montana, field, was brought in recently flowing 900 bbl. per day. Production is from the Sunburst sand at 2950-67 feet. The well was drilled with rotary tools and passed up the Sunburst, testing dry in the Cut Bank sand at 3055 feet. Operators had shot off the pipe and were pulling it for the purpose of abandoning the test when the well started flowing from the upper pay.

The Carter Oil Company and Associates' No. 1 Thompson, near Centrahoma in Coal County, Oklahoma, which has been the center of interest in that state for the last few weeks, has been abandoned. After drilling to 7126 ft. and failing to find a trace of oil pipe was pulled and the hole plugged.

●

A new pool has been discovered in Jefferson County, Texas, in the Gulf Coast area. The location is in the Amelia suburb of Beaumont. The successful test was that of the Humble Oil and Refining Company No. 1 Mrs. M. E. Langham, which produced oil from a total depth of 6796 feet. The gravity of the crude is 30 degrees.

●

Several miles east of Saginaw in the Thumb district of Michigan the Smith Petroleum Company has successfully completed its No. 1 Boyce Farm Company well, thus opening a new pool. Drilled to a total depth of 2832 ft. in the Dundee formation, the test was acidized, after which it produced at the rate of 100 bbl. in 24 hours on the swab. Lacking sufficient gas pressure to flow, the well was placed on the pump.

●

The first well to produce from the Tarkio lime on a commercial scale in Russell County, Kansas, and possibly in the state, has been completed by R. C. Tarrant of Cut Bank, Montana. The wildcat, two and a half miles south of the town of Russell, pumped 243 bbl. of oil in a 24-hour period after being acidized. The top of the Tarkio was picked up at 2522 ft., and the hole was carried to a total depth of 2550 feet.

●

An extension has been given to the Torrance-Redondo field of California by the completion of Thomas Clark's No. 1. The well is to the south of the old Redondo field and likely will result in the drilling of other wells in the area. At a total depth of 3552 ft., 150 bbl. of oil, cut seven percent, were produced the first day.

AVERAGE CRUDE PRICES

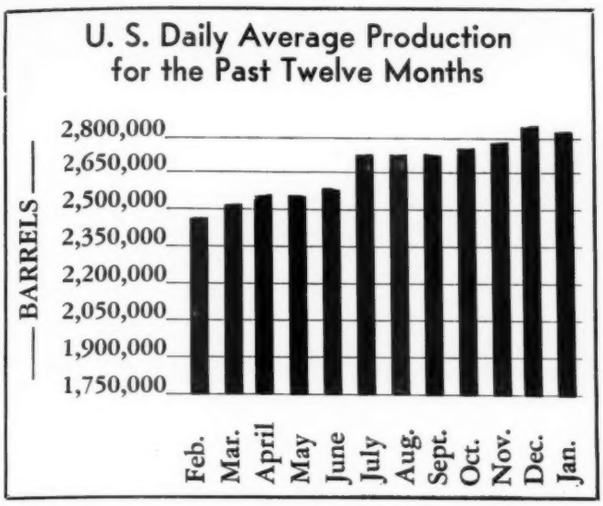
California	
Kettleman Hills	$ .97-$1.11
Playa Del Rey	.87
Coalinga	.76
Signal Hill	.86
Montana	1.45
Wyoming	1.10
Colorado	1.00-1.10
New Mexico	.75-.95
Texas	
North Central	.84-1.08
Panhandle	.81-.98
West Texas	.75-.95
Gulf Coast	.85-1.30
Darst Creek	.88-1.22
East Texas	1.15
Kansas	1.10
Oklahoma	1.10
Arkansas	.75-.80
Louisiana	
North Louisiana	$ .86-$1.10
Gulf Coast	.82-1.22
Illinois	1.23
Kentucky	1.23
Indiana	1.12
Ohio	
Lima	1.25
Michigan	1.12
Pennsylvania	
Bradford	2.45
Southwest	2.17
Eureka	2.12
Buckeye	1.97
Corning	1.42
West Virginia	1.67
Canada	2.10-2.17

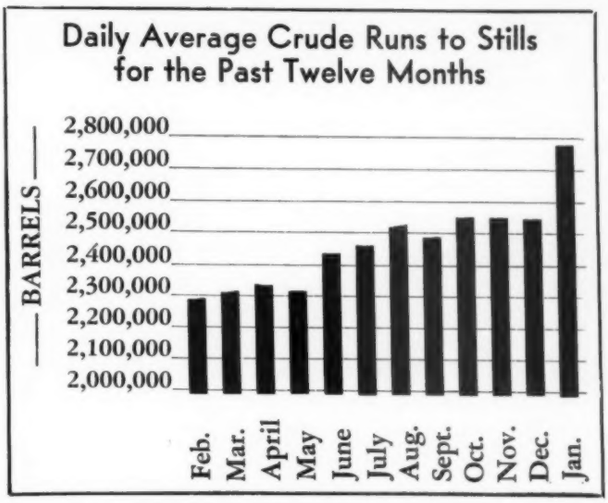
DAILY AVERAGE CRUDE OIL PRODUCTION

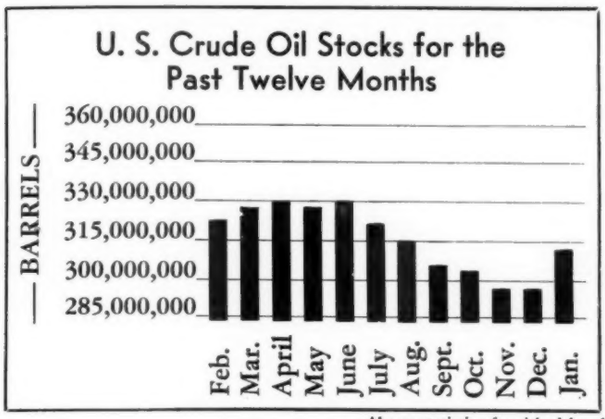
Furnished by A.P.I.

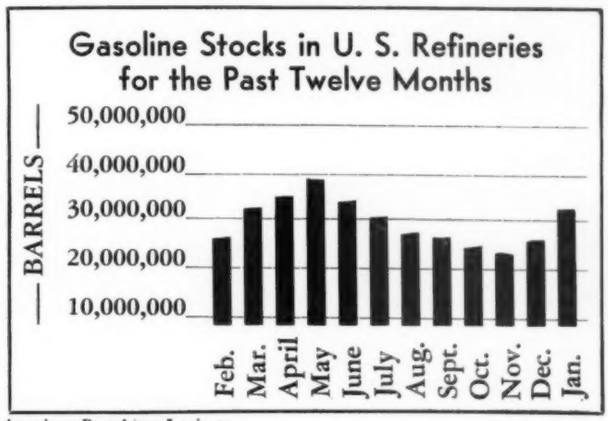
(Figures in Barrels)

	B. of M. Dept. of Interior Calculations (January)	Week Ended Feb. 1 1936	Week Ended Jan. 4 1936	Week Ended Feb. 2 1935
Oklahoma	481,000	497,250	462,800	441,300
Kansas	134,000	137,200	137,300	137,250
Panhandle Texas	.....	59,650	67,100	60,500
North Texas	.....	56,550	59,800	56,750
West Central Texas	.....	25,350	25,650	26,100
West Texas	.....	147,900	165,250	154,100
East Central Texas	.....	44,250	45,400	51,250
East Texas	.....	433,300	434,000	429,300
Southwest Texas	.....	68,800	64,050	58,400
Coastal Texas	.....	205,650	206,700	176,150
TOTAL TEXAS	1,017,200	1,041,450	1,067,950	1,012,550
North Louisiana	.....	57,350	34,550	22,850
Coastal Louisiana	.....	131,300	126,700	91,650
TOTAL LOUISIANA	132,600	188,650	161,250	114,500
Arkansas	28,900	30,200	29,700	31,500
Eastern	98,000	96,300	104,700	101,400
Michigan	42,200	40,200	49,650	36,100
Wyoming	33,200	33,750	36,550	31,950
Montana	11,300	13,750	13,150	10,650
Colorado	3,700	3,900	4,150	3,500
New Mexico	59,300	58,000	57,850	48,000
TOTAL EAST OF CALIF.	2,041,400	2,140,650	2,155,450	1,968,700
California	517,800	674,900	665,000	479,300
TOTAL UNITED STATES	2,559,200	2,815,550	2,820,450	2,448,000









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for January, 1936

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	243	241	85	115	3600	2	40	Rotary
Duval County	86	78	12	26	2300	2	22	Rotary
Archer County	53	25	20	30	660–1800	1 or 2	40	Rot.-Cab.
Conroe	1	1	1	2	2000–7400	3 or 4	40	Rotary
Panhandle	62	59	32	151	2200–3900	2	40	Rotary
Refugio County	4	4	2	3	5200	2	38	Rotary
OKLAHOMA								
Oklahoma City	29	25	5	42	6500	3	39	Rotary
Pontotoc County	40	36	10	66	1800–4488	2 or 3	38	Rotary
Osage County	22	18	13	46	380–2850	2	37.5–40	Rot.-Cab.
KANSAS								
McPherson County	5	4	2	4	2900–4300	2	38	Rot.-Cab.
Harvey County	2	2	1	1	3450	2 or 4	37	Rot.-Cab.
Ellsworth Arch	60	45	19	105	3300	4	37	Rot.-Cab.
CALIFORNIA								
Kettleman Hills	5	5	7	30	8300	3 or 4	40	Rotary
Long Beach	7	7	5	33	7000	3	36	Rotary

Field Activities by States for January, 1936

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1935 (In Barrels)
	January	December	January	December	January	December	January	December	January	December	
Arkansas	10	6	3	2	8	13	11	13	32	34	11,140,750
California	87	55	50	45	40	75	65	68	209	214	207,899,480
Colorado	....	1	....	1	....	....	1	2	25	29	1,565,150
Illinois	2	2	1	2	....	....	12	14	12	14	4,352,000
Indiana	24	....	8	....	....	....	3	2	53	56	762,000
Kansas	123	92	91	63	117	114	45	35	147	224	53,013,450
Kentucky	....	12	....	7	....	....	11	13	14	16	4,860,000
Louisiana	62	65	39	53	71	55	28	31	139	146	50,299,950
Michigan	79	57	54	40	56	37	81	90	84	95	15,661,350
Mississippi	....	1	....	0	....	....	1	1	9	10	Gas. Prod.
Montana	10	16	9	12	....	....	7	8	45	47	4,304,100
New Mexico	28	33	27	26	....	....	10	12	97	99	19,195,500
New York	....	....	....	....	....	....	3	4	2	4	3,191,900
Ohio	164	176	117	126	....	....	35	38	149	151	4,234,000
Oklahoma	260	211	185	155	192	192	47	64	407	511	181,152,050
Pennsylvania	....	9	....	5	....	....	18	20	86	97	14,478,000
Texas	943	803	739	604	754	659	270	295	802	887	377,747,205
West Virginia	67	25	49	17	....	....	17	19	98	109	3,818,400
Wyoming	4	8	3	7	....	....	6	7	54	59	13,320,100
Totals	1863	1570	1375	1163	1238	1173	671	758	2464	2813	970,995,385

THE MONTH'S ACTIVITIES IN REFINING

Percent Refinery Capacity Operated

Western Division, 60.5 percent **Central Division, 73.1** **Eastern Division, 75.1 percent**

THE Sinclair Refining Company is to install a polymerization unit at its East Chicago, Indiana, refinery. The plant will operate with cracked gases, handling approximately 4,500,000 cu. ft. daily. The unit will be the catalytic type developed by the Universal Oil Products Company.

•

The Pure Oil Company is modernizing its Toledo, Ohio, and Cabin Creek, West Virginia, refineries. The project will cost approximately $1,000,000. At the Cabin Creek plant a 2000-bbl. atmospheric distillation unit is being installed, as well as another still that is a combination topping, cracking, and reforming unit. The latter has a capacity of 2000 bbl. daily also. This unit will replace the existing Gyro cracking facilities. At Toledo, a combination topping, cracking, and stabilizing unit is being erected. It will have a crude capacity of 8000 bbl. daily, and a cracking capacity of 5500 barrels.

•

The Mid-Continent Petroleum Corporation, West Tulsa, Oklahoma, has signed a license agreement with the Universal Oil Products Company for the use of the Dubbs cracking process and henceforth will operate all its cracking equipment under that license. Mid-Continent will pay Universal for alleged past infringement and the latter also acquires rights under more than 20 patents belonging to Mid-Continent and a number of applications pending in the patent office, it is announced.

•

The Pelican Oil and Gasoline Company, Inc., is erecting a natural gasoline absorption plant in the Rodessa field of Louisiana. Construction work is under way now and the plant, which will have a capacity of 50,000,000 cu. ft. of gas daily, is expected to be completed by April.

The Frick-Reid Supply Corporation, of Tulsa, Oklahoma, has been awarded the general contract for the erection of the plant, with the engineering being done by the Burrell-Mase Engineering Company, Tulsa, and construction work sublet to Mattison-Wallack and Company, Oklahoma City.

•

The Wood-Moore Corporation's 2000-bbl. refinery at Port Isabel, Texas, on the Gulf Coast, is nearing completion. All that remains to be done is the installation of pumping equipment. Unfavorable weather has hampered construction work the last few weeks.

•

According to recent reports the Panama Refining Company of Overton, Texas, will erect in the Rodessa field of Caddo Parish, Louisiana, a refinery having capacity of 7000 bbl. daily.

•

Eastern States Petroleum Company, Inc., has started construction of a simultaneous topping and Dubbs 2-coil, selective cracking unit, to process 10,000 bbl. of East Texas crude a day, crack 6400 bbl. of topped crude daily, and reform 1100 bbl. of naphtha. The new unit is to be built at the plant of Deepwater Refineries, Inc., on the Houston ship channel. The Deepwater refinery was recently taken over by Eastern States.

R. B. Kahle, president of Eastern States, is well-known in the refining and marketing industry, formerly having been identified with the Louisiana Oil Refining Company and the Beacon Oil Company. L. J. Walsh is vice-president of Eastern States.

Allen M. Peairs, of Dallas, is the contractor.

•

A new cracking unit having 1000-bbl. capacity is being installed by the Midway Refining Company at its Pettus, Texas, plant. S. J. Moore of San Antonio recently purchased the plant from the Bee Oil and Refining Company. Construction of the new unit will give the plant a capacity of 1800 bbl. daily.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending February 1, 1936

A.P.I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	492,000	80.4	15,225	6,888
Appalachian	94.8	97,000	66.4	2,574	675
Ind., Ill., Ky.	95.9	333,000	78.5	9,867	2,868
Okla., Kans., Mo.	84.8	266,000	69.3	6,611	3,120
Inland Texas	48.5	108,000	67.5	1,470	1,528
Texas Gulf	96.8	625,000	95.0	7,731	8,934
La. Gulf	96.4	118,000	72.4	1,551	3,637
No. La.-Ark.	90.0	44,000	61.1	375	588
Rocky Mt.	61.9	34,000	56.7	1,155	733
California	92.6	507,000	64.3	12,489	69,897
Reported	89.6	2,624,000	75.7	59,048	98,868
Est. Unreported		196,000		3,579	4,639
*EST. TOTAL U. S. Feb. 1, '36		2,820,000		62,627	103,507
*EST. TOTAL U. S. Jan. 25, '36		2,800,000		60,014	104,754
U. S. B. of M. Jan., 1935		2,434,000		**58,605	**104,147

*Bureau of Mines basis currently estimated.
**As of January 31, 1935.

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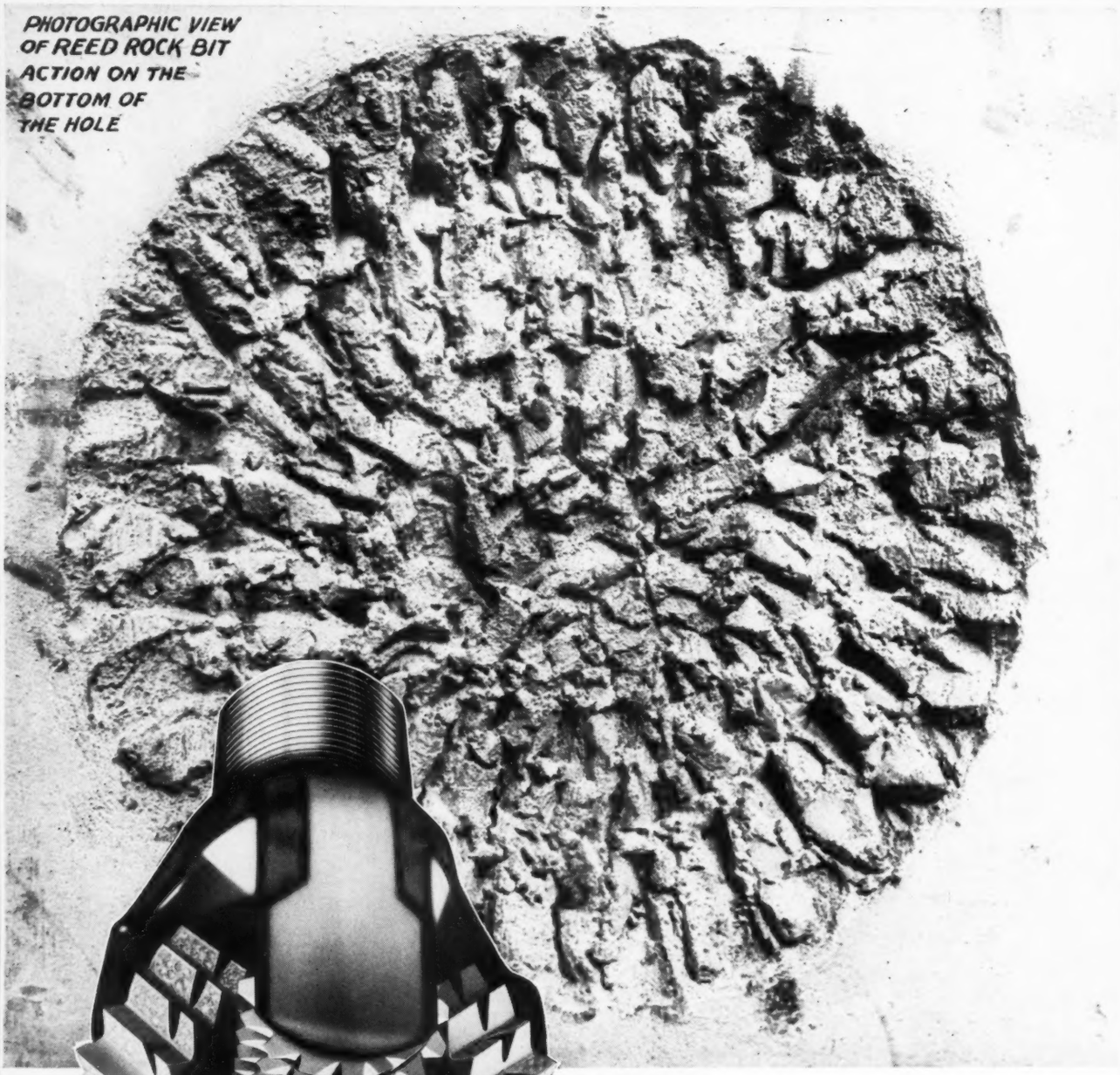

PHOTOGRAPHIC VIEW OF REED ROCK BIT ACTION ON THE BOTTOM OF THE HOLE

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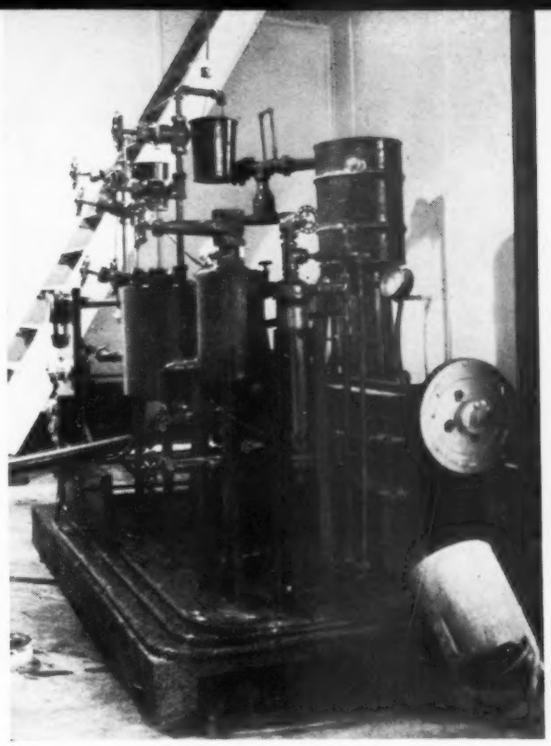


Fig. 1. Apparatus for testing cake thickness and filtration of mud under conditions simulating those in bottom of hole

By

WALLACE A. SAWDON

Petroleum Engineer, Los Angeles

Lost Circulation in Rotary Holes---A Problem Requiring Specific Treatment

THANKS to extensive research work and to knowledge gained through practical experience, the problem of regaining lost circulation in drilling wells is now met with more understanding than in previous years. So many factors are involved and so many different conditions encountered that no one method, no one material, or no variation of one method or material can be established as a general solution to the trouble.

Lost circulation sometimes can be prevented and there is every reason to believe that many wells have been drilled with little or no loss of drilling mud that would have caused a lot of trouble had the mud not been properly conditioned —and kept so conditioned constantly during drilling. Moreover, in many fields where previous knowledge has indicated danger at certain depths, the mud has been especially prepared to meet the conditions that were expected to exist. With mechanical coring and electrical logging so readily available as it is today a warning of trouble is frequently given. The action of colloidal and other properties of a mud are widely known and their control has been the means of preventing trouble and of facilitating drilling. Not the least of the troubles prevented has been partial—and perhaps total —loss of circulation.

Formations causing a loss of circulation vary widely in their characteristics. They range from a mere porous stratum to a bed with interlacing fissures or crevices. The depth at which the stratum lies will have its influence. A stratum at 1000 ft. might cause little or no trouble, while one of identical characteristics at 7000 ft. might carry away even a specially prepared mud; but a formation that is really cavernous, no matter its depth, will cause trouble. This is clearly indicated by the following statement by W. T. Doherty[1] regarding the Barbers Hill field in Texas, where a vertical well must pass through a limestone cap rock, an anhydrate, an overhanging salt plug, then shale, and finally into the producing sand.

"The porous cap rock and salt formations of Barbers Hill offered a difficult drilling problem. Earlier experiences in attempting to regain lost returns usually met with failures. Tons of cottonseed hulls, bales of cotton, thousands of sacks of cement, beet pulp, manure and asphalt often failed to seal off the formations; and a number of wells, using salt water as circulation fluid, were completed without returns.

"Finally, one operator conceived the idea of using an admixture of bentonite and cement—on the basis of the gelling properties of the mixture—which subsequently increased the angle of repose."

Admixtures of materials in great variety have been tried in many wells in all parts of the country. In a well in the Midway field, California, for instance, where circulation was lost, presumably through crevices, with a highly colloidal mud of maximum viscosity 580 tons of dry mud, 650 sacks of cement, 660 sacks of cottonseed hulls, 781 sacks of sawdust, and 23 bales of hay failed to regain circulation. In this particular case, chemicals were finally used and the desired results obtained.

Colloidal Material

There have been many cases where circulation has been partially or totally lost but later regained by specially conditioning the mud with a high percentage of colloidal matter. In some cases where weight is not necessary for protection, it has been found that a circulating fluid consisting only of water and a colloidal admixture—mixed perhaps to a viscosity just within a pumpable range—will provide a means of getting through a formation that otherwise would rob the hole of fluid.

The gel formed by colloidal material generally will set up in a few hours. After the amount of treated mud thought necessary has been pumped into the formation or crevices, the pumps usually are shut down for five or six hours. When circulation has been regained, the mud is thinned and conditioned back to normal.

Should the use of highly colloidal mud alone be insufficient to regain circulation, the effectiveness of other materials added, such as cottonseed hulls, sawdust, peat moss, beet pulp, etc.,—will certainly be enhanced by the gelling

[1] "Oil Well Cementing in the Gulf Coast Area," by W. T. Doherty. *A.P.I. Bulletin No. 212.*

properties of the fluid. The use of such materials with a fluid rich in colloids has been used with success in many cases where circulation has been lost through fissures or crevices. Tests under high pressure and temperatures have been made with cores made with cottonsed hulls and beet pulp mixed with colloidal mud.

Testing Apparatus

While the research work now being conducted on muds and drilling fluids does not aim primarily to solve problems of lost circulation, applying the knowledge gained has resulted in preventing and overcoming lost circulation in cases where extreme measures were patently unnecessary. Plastering ability and imperviousness in mud, obtainable by the addition of physical admixtures or by the use of chemicals with the mud, are effective properties in the prevention and regaining of lost circulation.

A filter press for the testing of mud samples recently has been installed by one manufacturer of a specially treated bentonite. This apparatus, shown in Fig. 1, is similar to the one designed by the Union Oil Company of California that has proved of great value in the extensive research work being conducted with excellent results by that company. With this equipment bottom-hole conditions of pressure and temperature are simulated and the action of such conditions on drilling muds determined.

When testing with this apparatus, formation cores are placed in a core chamber and securely fastened in place. The mud to be tested is then put in a circulating system, which is closed by high-pressure valves. Any desired pressure up to 6000 lb. per sq. in. is then built up. By means of electric coils surrounding the mud circulating pump and by an oil bath fitted with electrical heating elements surrounding the test chamber in which the mud circulates over the core, any temperature up to 300 deg. fahr. can be obtained. A desired temperature is maintained by thermostat control.

Before a run is started, the mud is tested for weight, viscosity, percent of solids, pH value, and gel strength. The porosity and permeability of the cores used (generally taken from the well in which the mud is being circulated) are also determined. The conclusions reached in a test are based on thickness of cake built on the core; total amount of water that penetrates the cake and the core; and the rate of filtration through the cake and the core in milliliters per minute.

For testing muds containing fibrous materials, cottonseed hulls, beet tops, and similar substances, a filter press, shown diagramatically in Fig. 2, is employed. A porous formation of any character desired is built up in the test chamber and is fed through a pipe from a pressure chamber containing a sliding plug. The admixture of mud and whatever material is mixed with it is introduced into one side of the plug. Pressure is applied with water on the other side of the plug to the amount desired.

Any fluid passing through the formation is taken off at the bottom of the test chamber. Three gauges are on the test chamber: one above the porous formation and two below the top of the formation. The two gauges below are for recording any pressure that might be built up if the sealing mixture ever penetrated the formation as far as the gauges. In all tests made, however, pressure has built up on the upper gauge as the cake was formed but no pressure has yet been indicated on either of the lower gauges.

The cakes formed by tests made with this apparatus on various materials mixed with mud are shown in Fig. 3. These show the physical characteristics of the plaster built up with certain materials. Conclusions made from the result of tests, however, include the thickness of the cake and the filtration through it in milliliters per minute.

Fibrous Material

Considerable attention is being given to the use of fibrous material mixed with the mud to regain lost circulation. The successful applications of such a mixture in the Fitts pool and in other areas of Oklahoma, in Kansas and in the Texas Panhandle, have been described in a previous article.[2] In California, fibrous material has also been used in field operations, the fibers having been mixed with mud having good colloidal properties. Furthermore, a number of tests have been made with mixtures of mud and fibrous materials and of mud and other materials such as cottonseed hulls, beet pulp, and similar substances to determine the efficiency of such mixtures on porous strata. The cakes formed by using the apparatus shown in Fig. 2 in making tests with various materials and with fibers of different lengths on cores made with different size gravel are illustrated in Fig. 3. It has been found in making these tests that the size and character of the fibrous materials have a distinct influence on the effectiveness of the plaster formed.

The fibrous materials used in the tests illustrated were made of bagasse (sugar cane stalks from which the sugar has been removed). When prepared for mixture with mud, such material is treated, waterproofed, and shredded; and the extent to which the material is refined and ground affects its individual fiber length and pithy property. For convenience in identifying the substance used in making the cakes illustrated, the following arbitrary letters have been assigned to the types composing the mixture:

A. Made from raw bagasse, treated and coarsely ground;

[2] "Fibrous Material in Cement and Drilling Fluids to Prevent Loss of Cement or Mud Into Formation" by C. P. Parsons, *The Petroleum Engineer*, November, 1935.

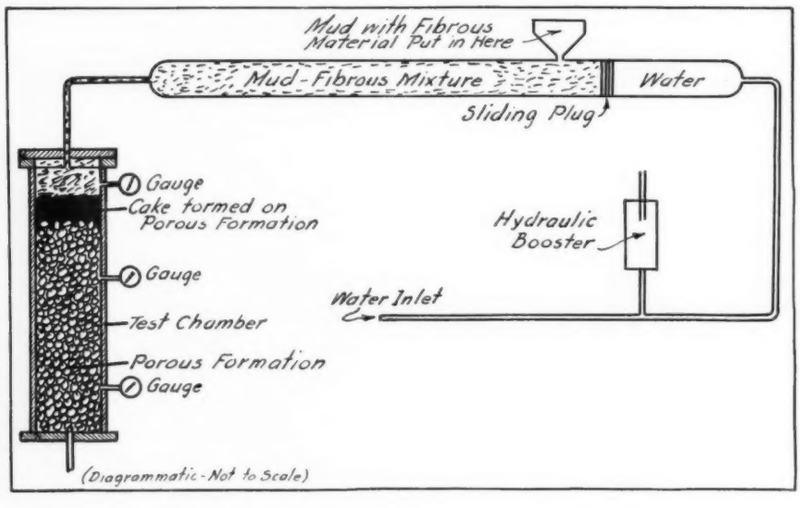


Fig. 2. Filter press for testing fibrous material, beet pulp, cottonseed hulls, etc., with mud fluid

little refined and containing practically no pithy material. Fibers range in length up to about one inch.

B. More refined than A, with more pithy material and shorter lengths.

C. Similar to B but with a large percentage of moisture which may run as high as 50 percent.

The larger fibers evidently have an advantage when the openings to be shut off are large. When using them, however, it would seem that a mixture with a smaller, more pithy material is necessary.

Use of Cement

In the aforementioned article,[2] C. P. Parsons describes a method for sealing off "thirsty" formations that cause trouble in cementing jobs. He also brings out the fact that even though a loss of drilling fluid may be overcome by plastering up the wall of a hole, there is a possibility of the seal being broken during a subsequent cementing job. Loss of cement during a cementing job is always of serious concern; and no matter what method is used in regaining partial or total loss of circulation, due consideration must be taken of the effect by or on the cement of any seal that has been formed on the face of a formation that must ultimately be in contact with the cement.

Going further, Parsons describes a method of using "fibered" cement—a cement pre-mixed with a definite percentage of fibrous material contained therein—to prevent a loss of cement slurry into the formation. While this might preclude the necessity for previously sealing the wall during drilling operations where circulation loss would be small or economically disregarded, the use of a "self-sealing" cement, made by the addition of fibrous material or some other ingredient, often will be an insurance against failure even when the formations have been plastered effectively during drilling operations.

Fibered cement would, moreover, seem to offer possibilities for recovery of circulation under more serious conditions. Neat cement itself has been used to advantage in many cases where it can be kept in place until it sets. Cement can probably not be equalled as a means of stopping lost circulation when it can be made to fill completely the voids or crevices through which the fluid is lost.

The "admixture of bentonite and cement" referred to above[1] has been widely used in many parts of the country for recovering lost circulation. Its general properties have been fully discussed in a previous article.[3] The most valuable asset in regaining lost circulation with this gel-cement is, of course, its ability to provide all the advantages of cement by keeping the cement in place until it sets. In addition, it appears from experimental tests that the water used in mixing the gel-cement is retained in the body of the mix and does not arise to the surface to present a weak point through which the fluid can pass even when a crevice has been filled with cement to the face of the hole.

The greatest advantage in the use of gel-cement is naturally in shutting off badly fissured or cavernous formations. Since the actual subsurface conditions are not always known, the procedure with some operators in California is to thicken up the mud to a highly colloidal degree when circulation is lost. If this does not regain circulation, cottonseed hulls, beet pulp, or some similar substance is introduced. When this fails, it is considered that the formation is such that the use of gel-cement is necessary. In this way, no considerable expense is involved and a shut-down is eliminated with the ever-present possibility of regaining circulation without the use of cement.

Doherty states[1] that "The bentonite has no detrimental effect on the cement when mixed in proper proportions, viz, four percent by volume of bentonite of volume of cement, or four sacks of bentonite to 100 sacks of cement. The mixture, after coming to rest, will—within two to five sec. after having been poured out of a vessel onto a glass plate—become a stiff jelly-like paste with an angle of repose of 60 degrees."

The angle of repose—which is of considerable importance in regaining lost circulation—obtainable under most conditions will probably average around 45 degrees. This will vary, as will also the viscosity, by the amounts of water and gel-material used. Extreme cases are illustrated in Figs. 4 and 5. A high water-cement ratio mix can be given a high angle of repose by the introduction of more gel-material. Since the strength of the cement varies with the amount of water used such a mix would be weak. An equally high angle of repose can be obtained with less water and less gel-material and at the same time be a stronger cement.

The use of too much gel-material, resulting in a stiffer mix,

[3] "Gel-Cement—Its Use and Application in Drilling Wells," by W. A. Sawdon, *The Petroleum Engineer*, April, 1935.

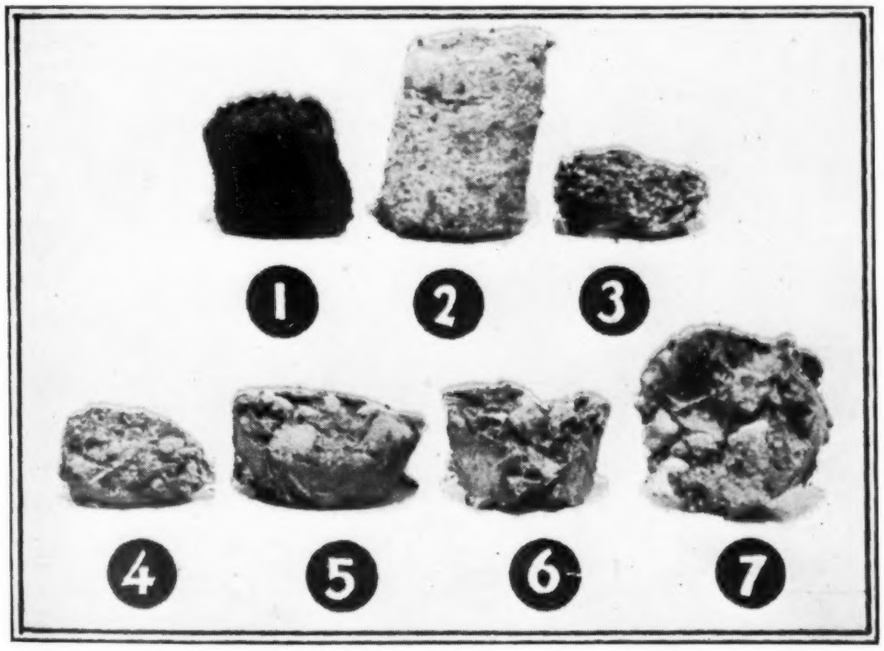


Fig. 3. Cakes formed by mud mixed with fibrous and other materials.

1. Beet pulp with 72-lb. mud on 3/8-in. formation. Formed under 3000-lb. pressure.
2. Cottonseed hulls, 3 percent in 72-lb., 7-centipoise mud on 3/4-in. formation. Formed under 3000-lb. pressure.
3. Fibrous material, 3 percent type C (see text) in 72-lb., 7-centipoise mud on 1/4-in. formation. Formed under 3000-lb. pressure.
4. Fibrous material, 3 percent type C (see text) in 72-lb., 7-centipoise mud on 1/2-in. formation. Formed under 3000-lb. pressure.
5. Fibrous material, 1.5 percent type A (see text) and 1.5 percent type B, in 72-lb., 7-centipoise mud on 3/4-in. formation. Formed under 3000-lb. pressure.
6. Fibrous material, 1.5 percent type A (see text) and 1.5 percent type B in 72-lb., 15-centipoise mud on 1-in. formation. Formed under 3000-lb. pressure.

Fig. 5. Gel-cement made with seven sacks of gel-material per 100 sacks of cement. Water-cement ratio: 16 gal. water per sack of cement

will not always be advantageous even though it is pumpable. Gel-cement may be pumped easily even when it has to be shoveled into the hopper. But when the consistency is so great, it may not flow far enough into small crevices to block them off completely when the cement is drilled out. In planing the mix, the water-cement ratio as well as the gel-cement ratio must be considered.

Chemicals

The chemicals being used with mud are prepared for conditioning the circulating fluid as well as for overcoming the obstacles of lost circulation, heaving shale, caving, etc. This should be kept in mind when the use of chemicals is the means taken to condition the fluid. Like all other controlled drilling fluid, however, the chemically-treated mud that best meets normal drilling requirements cannot overcome such unusual conditions as highly porous formations, fissured zones, or crevices without special treatment.

The application of chemicals should be done under competent supervision. Several of the oil companies in California have, for several years, done considerable research work on chemical treatment; and have employed able chemists who have not only developed their own formulas but also supervise the use of the chemicals in the field. Manufacturers of chemical compounds have likewise developed formulas and some, in addition to providing technical advice on the solution of problems, have service organizations that supervise the application of their compounds in the field.

The chemicals in general use are supplied in both powder and liquid form. To regain lost circulation, the usual method of application is the introduction of one chemical or formula into the circulating fluid and then introduce another that will cause a precipitation. This precipitation may range from a gel-like mass to one of considerable solidity, and with some chemicals is basically crystalline in structure and with others a matty substance. The different chemicals, however, are not always introduced separately into the well. A recent job of regaining lost circulation in a California well was successfully performed by mixing the chemicals in the mud fluid at the same time.

The object is, of course, to form an impervious plaster on porous faces; or, in fissured or cavernous formations, to build up a mass that is impervious in itself or provides means for the formation of an impervious plaster on it. In extreme cases, the chemical is precipitated some distance in the crevice or fissure and starts the formation of the mass, which builds up to close the opening.

Some chemists prefer standard chemicals for use in regaining lost circulation. Many use sodium silicate, which is precipitated by any one of a number of chemicals such as aluminum sulphate. The precipitate is selected mainly for the speed of reaction and will frequently consist of more than one chemical.

Chemicals manufactured especially for oil well service are usually formulas developed to meet well conditions with economy and effectiveness. These formulas are based on results obtained through experience and provide gradation of reaction to take care of specific cases. The bare statement of the technical factors that enter into the use of chemicals for regaining lost circulation would seem to indicate a complex procedure to be followed. Yet, with a knowledge of the mud and water to be used and with the other data that are generally available, the proper chemicals and their amounts are readily determined and used by one experienced in this work.

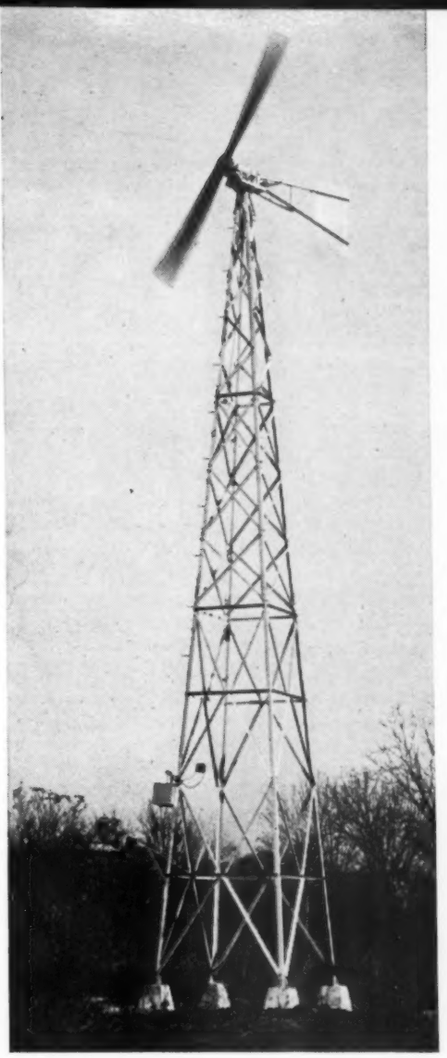
Plaster formed by chemicals should be considered for its effect on cement slurry that later have to be placed in contact with the sealed-off formation. When the cement job does not require a quick-set reagent, this factor is generally not so important. It can readily be seen that if calcium chloride is used with the cement that must contact a plaster made by chemicals which included calcium chloride, there might be danger of an excess harming the cement. Any chemicals that might contaminate the cement should be avoided. It is the author's understanding that chemicals manufactured specially for oil well use will form a plaster that is devoid of harmful reactions.

Conclusion

General recommendations can not be made on the methods and materials best suited to meet all problems of lost circulation. It is only after the conditions pertaining to a particular well are known that the best procedure can be followed.

One method successful in one well might be a failure on another. On the other hand, any one of several methods might be equally successful. Many cases of lost circulation have been eliminated by keeping the drilling fluid properly conditioned.

Fig. 4. Gel-cement made with two sacks of gel-material per 100 sacks of cement. Water-cement ratio: seven gal. water per sack of cement



One of the newer installations of wind-powered generator units

New Developments in Wind-Powered Generators for Cathodic Protection of Pipe Lines

Latest type units are equipped with a perfected automatic current regulator, and can start operating on as low as three miles per hour wind velocity

By FRANK H. LOVE

RECENT developments in the design and construction of wind-powered generator units for use in the cathodic protection of pipe lines have resulted in a vast increase in their efficiency and greatly widened the field of application. The developments of most outstanding importance are two: A perfected automatic current regulator, and certain improvements that enable the unit to commence operating on a lower wind velocity than formerly. The automatic regulator serves to maintain current at the rated output of the unit regardless of external resistance, while the wind velocity required for starting is now three to three and one-half miles per hour rather than eight miles. The eight miles per hour velocity, while workable, was not found desirable under all circumstances. In areas where wind velocity was low too great a down time was experienced for the units to accomplish their work efficiently. With these major improvements, in addition to certain minor ones, the units now can be depended upon to operate more than 50 percent of the time, whereas originally they performed on a basis of approximately 30 percent.

As is generally known, the purpose of the wind-driven generator is to supply electric current for use in combating electrolysis of pipe lines, employing natural power—the wind. Charging the soil surrounding a pipe line with an electric current so that the latter will find its way back to the generator by way of the pipe line, thus maintaining a negative potential of the line with reference to the soil and virtually eliminating corrosion resulting from electrolysis, is a practice that has been in use for a number of years. The wind-powered generator, however, is a recent development, and tests made to date have established its practicability, especially in areas where purchased power is not available.

Initially designated for The Texas Pipe Line Company and installed on that company's system under the direction of J. L. Culbertson, chief engineer, the results of the first tests were so favorable that the Texas organization not only has made additional installations but other major companies have been converted to their use. The United Gas Public Service Company has placed three of the units on its Jennings-Roma line in South Texas, and the Humble Pipe Line Company at present is making an installation in the Trinity River bottoms near Liberty, Texas. The latter, naturally, has had no opportunity to obtain operating data. The United, however, having had their units in operation since October, has gathered considerable interesting and valuable information.

A few days after the istallation was completed tests were conducted to determine the volts, revolutions per minute, amperes, and ground resistance of each unit. The following gives the results in tabulated form:

Generator No. 1

Volts	*R.P.M. of Generator*	*Amps.*
5	720	24.3
5.8	1140	24.8
5.5	1080	23.8
5.9	1320	24.8
6.1	1370	24.8

Resistance of circuit: .24 ohm

Generator No. 2

Volts	*R.P.M. of Generator*	*Amps.*
	400	13.5
	370	9.0
	390	10.8
	380	11.7
	320	6.3
	350	7.6
10	320	9.9
10	420	10.8
9	490	16.2
11	600	21.6
	800	21.6
	590	21.6

Resistance: approximately one ohm

Generator No. 3

Volts	*R.P.M. of Generator*	*Amps.*
7.5	1150	22.5
7.9	1050	22.5
7.9	1000	22.5
7.9	1200	23.0
8.0	950	22.5

Resistance: .34 ohm

When these tests were made the units were operating on a wind velocity of from four to eight miles per hour. In connection with Generator No. 2, the resistance of one ohm was found to be much higher than the generator was designed for and salt water was poured over the ground bed with the thought that were it possible to start corrosion the resulting products, being hydroscopic salt, would retain moisture in that area and thus serve to reduce the resistance.

Approximately a month later another inspection was made to ascertain the condition existing after the generators had been in operation that period of time. The current output of each generator was measured. One, No. 3, was found to be producing but 14 amperes, and, as a result, the cover plates were removed, the commutator cleaned, and hard-surface brushes installed, after which the output of the unit increased to from 21 to 25 amperes. An ammeter also was installed on unit No. 3, by the simple expedient of placing a knife switch in the ground bed circuit and shunting the ammeter around this switch. Thus when the switch was closed no current passed through the meter, and, when knowledge of the output was desired, it was merely necessary to open the switch. This installation was a safety measure for the meter, since at times a strong wind would increase the output of the generator to 40 or 50 amperes before the automatic features of the unit could act to cut the propeller out of the wind and reduce its speed. The maximum reading of the ammeter was but 30 amperes, which was greater than the normal output of the generator. It should be mentioned, however, that the new generators are of 40 ampere capacity.

This second inspection also served to reveal that the resistance of the ground beds had changed considerably since the first tests, probably due to the fact that hydroscopic salts had formed at the point of contact of the pipe with the ground, reducing the resistance by maintaining a wet area at that junction. It will be noted from the figures immediately following that the greatest reduction in resistance was at Generator No. 2, the one showing such an exceptionally high resistance on the first test. Salt water used to start corrosion on the ground bed is credited with obtaining this result.

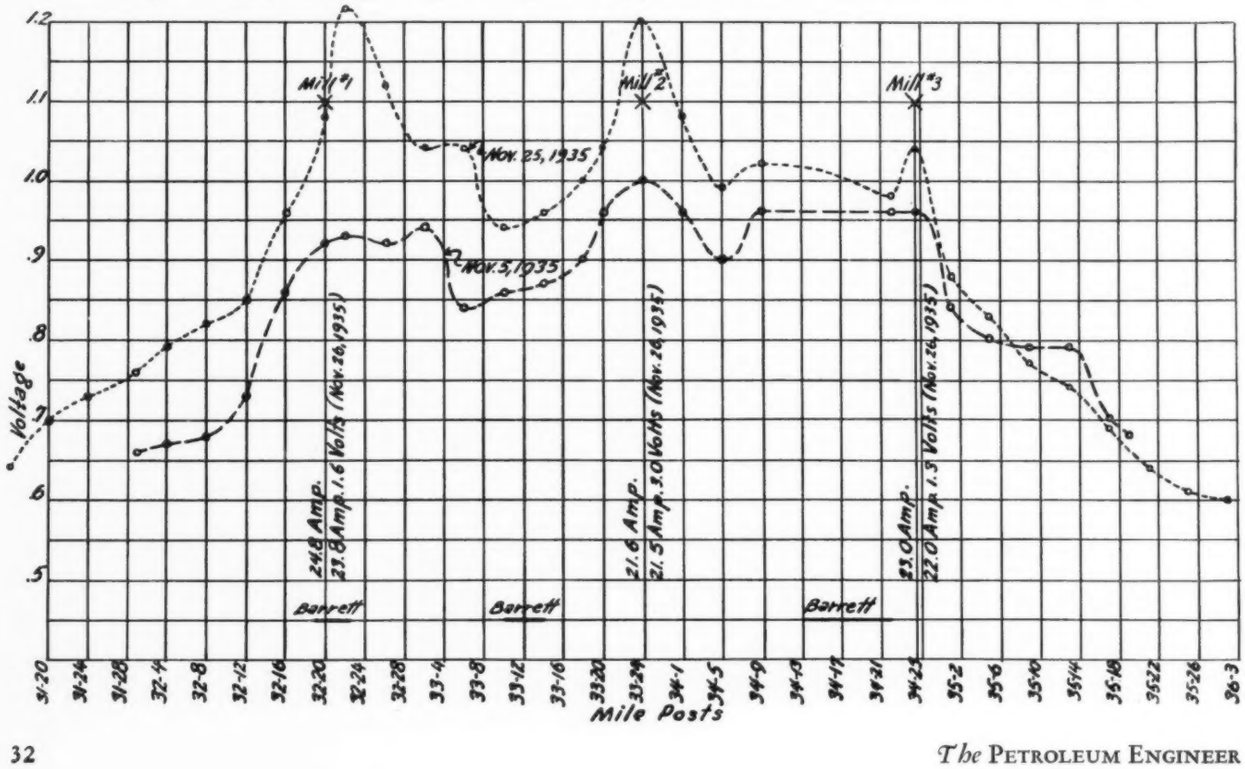
Ground Bed Resistances

Generator Number	*Resistance in Ohms 11/5/35*	*Resistance in Ohms 11/25/35*	*Decrease of Resistance in Ohms*
1	.24	.067	.173
2	1.00	.139	.861
3	.34	.059	.281

Results obtained from the installations made thus far by The Texas Pipe Line Company and the United Gas Public Service Company have proved exceptionally satisfactory. So much so that the former has nine units in service, is installing another at present, and plans additional ones as needed. The United Gas Public Service Company also is making preparations for further installations on its system. An accompanying diagram, Fig. 1, demonstrates the extent to which protection is given by the three installations of the United. The section of line above the .8 voltage is under positive protection, while the area between .65 and .8 is partially protected. The two curves represent conditions at the time of two separate tests taken over the section of line affected by this installation. The first test was made a few days after the unit was installed, the second 21 days later. Exceptionally favorable wind velocity had prevailed for 48 hours prior to the taking of the second readings.

As a result of its observations the engineering personnel of the United Gas Public Service Company has arrived at the

Fig. 1. Voltage readings along Jennings-Roma pipe line of United Gas Public Service Company



conclusion that in the future it will be possible to reduce the cost per mile of pipe protection in the following manners: (1) The new units will be of 40 ampere capacity with an increased cost of $50.00 each. This greater amperage will afford about one-half mile more protection per generator, making the section of line protected by each unit approximately one and one-half miles. (2) Shallow ditching and immediate treating with calcium chloride will have a tendency to collect water at the point of ground and pipe contact, thereby reducing ground resistance. (3) It is possible to reduce the ground bed from 400 ft. to 300 feet.

The wind-powered generator unit as now designed consists of a shunt-wound generator to which an airplane-type propeller is directly connected through speed increasing gears. The gears are steel-cut, of the helical type, and specially designed for this particular use. The gear ratio is three and one-half to one, that is, each revolution made by the propeller results in the armature of the generator turning three and one-half times. The wires from the commutator brushes of the generator are connected to a set of slip rings and the brushes on the rings are attached to wires, the positive wire leading to the ground bed, the negative wire to the pipe line. The generator is set on a turntable and the entire assembly is mounted on a tower varying in height from 40 ft. to 60 ft., depending upon the surrounding terrain. Some of these towers are four-legged affairs constructed of steel, others are A-frames made of creosoted pine.

Since at no location is the wind velocity constant, special care has been taken to prevent the generator from being "burned up" during a period of excessive speed and consequent excessive electrical output. A resistance has been placed in series with the field coil of the generator, which is "cut in" by the opening of the two points that are regulated by the quantity of current in the lines running to the pipe line ground bed circuit. As these points open, resistance gradually is cut into the shunt field of the generator, reducing the current and causing a reduction of the magnetic flux in the generator, thereby holding the current output to a preset maximum.

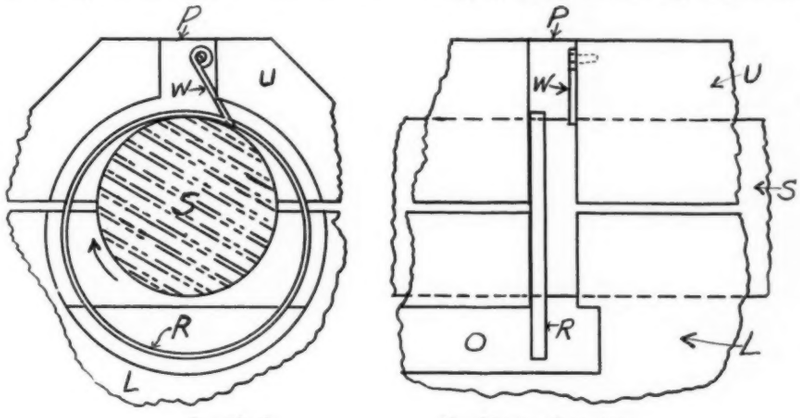
How Lubrication Trouble Was Remedied on Pump Drive Shaft

By ELTON STERRETT

ACCURATELY levelled and carefully aligned, the driveshafts from a battery of Diesels to pump reduction gear pinions gave no trouble through upwards of three years of uninterrupted service; then, as each cold snap approached, they began to develop hot bearings, and the colder the weather, the more trouble from overheated bearings.

The primary cause of the trouble was easily determined—the ring oilers were traveling to the sides of the annular space in which they revolved, and were being held there by the viscous oil film and by the added resistance of the sump oil to the passage of the ring through it.

It was a case of the friction of ring on shaft at the tangential contact exerting less pull than the sum of the drags in oil and against bearing shoulder—and when the ring ceased revolving the shaft lost its source of lubricant supply, and then would heat excessively in the time between oilers' rounds. Always when found stuck a ring would resume revolving at the slightest touch, and with the tenacious film of oil broken, would run for some time before again finding conditions just right to brake the revolving ring and then stop it completely.



S—Shaft
R—Oiling ring
P—Peep slot
O—Oil sump
U—Upper bearing
L—Lower bearing
W—Fender wire

Sketch showing how fender wire was placed to hold oiling ring R off the right shoulder at right on upper and lower bearings U and L

As with the cause, so was the remedy simple. A short piece of No. 14 wire was formed with an eye in one end, and a 3/16-in. hole drilled and tapped into the upper bearing shell near the top of the peep slot. With a stove bolt through the eye of the wire and screwed into this hole, the bit of wire was held in such a position that it served as a fender to keep the ring from contact with the bearing side wall—exchanging a long flat bearing surface for a thin almost point-like rubbing area.

Once these wire guides were placed, care being taken to determine first the side of the slot toward which the ring traveled, the oiling rings were observed to travel as freely when the temperature of the station dropped and the oil tended to thicken as when the station temperature was high.

For the sake of clearness, the ring "R" in the sketch is shown adhering to the left side of the section of bearing in order to illustrate the extent of surface over which the viscous drag of cold oil could operate, although in reality the travel of that particular ring was toward and against the right shoulder, the shoulder on which, as shown in sketch, the fender wire was placed.

A Bureau of Mines Study of a "Bottom Hole" Sample from the Crescent Pool, Oklahoma

with Regard to Liberation of Gas, Expansion of the Oil-Gas Mixture, and Energy Relations Involved in Flow[1]

By BEN E. LINDSLY[2]

Part I

INTRODUCTION

THE desire of the petroleum industry to increase the efficiency of flow of oil and gas through producing formations and in wells has stimulated thought toward methods of determining the energy relations involved in the various stages of flow from the reservoir formations to the tanks at the wellhead. In an earlier report[3] the writer described a method for determining with reasonable accuracy the work that a given volume of reservoir oil can perform when expanding isothermally. Data relating to the work done and the volumes occupied by oil-gas mixtures in expanding apply directly to the design of flow strings and other production problems.

Interpretation of data obtained from experiments with "bottom-hole" samples is helpful to a study of the transformations of energy involved in the flow and expansion of the reservoir fluid as it moves from its position in the sand to the surface. The oil at the bottom of the well usually is not identical in properties with that distant from the well in the reservoir formations, because under flowing conditions pressures in the formation and in the well are not the same. A differential pressure must exist in the sand to cause flow toward the well, and some of the lighter hydrocarbons may be liberated from the oil to form gas as the fluid passes through the formation. The pressure gradient often is considerable and becomes greater as the rate of production from the well is increased. However, if the reservoir oil is undersaturated with the gas-forming hydrocarbons at the pressure existing in the bottom of the well during flow, as in many wells of the East Texas field, a sample of oil taken at the bottom of the well will be almost identical with the reservoir fluid. Under some conditions of flow in certain wells a "bottom-hole" sample will not differ greatly from the reservoir fluid, even though the oil is saturated with gas-forming constituents at the reservoir pressure. Such a condition seemed to exist in the Crescent pool, Logan County, Okla., in the fall of 1933.

The "bottom-hole" sample used in the experiments discussed in this report was obtained on September 23, 1933, when there was only one producing well in the Crescent pool. As this well had been allowed to flow for only a few hours each month the sample of oil taken at the bottom of the well may be considered a reasonably close representation of the oil in the formation prior to drilling. However, in view of the limited development of the field and the fact that check samples were not obtained, this paper should be considered only as a progress report, to be followed by similar investigations in other fields.

ACKNOWLEDGMENTS

This study was made under the direction of R. A. Cattell, chief engineer, Petroleum and Natural-Gas Division, Bureau of Mines, and N. A. C. Smith, supervising engineer of the Bureau's Petroleum Experiment Station at Bartlesville, Okla. The funds used in the work were supplied in part by the State of Oklahoma.

The author is grateful to the Gypsy Oil Co. and Carter Oil Co., which furnished the well for sampling, assisted in taking the sample, and gave the work their full coöperation and support. Thanks are due also to the Phillips Petroleum Co., which supplied laboratory space and the assistance of William H. Barlow in performing the experiments on the sample. The information furnished by C. L. Tolivar of the Gypsy Oil Co., C. V. Sidwell of the Amerada Petroleum Corporation, who made the pressure traverse upon which many of the calculations are based, and Donald L. Katz, Phillips Petroleum Co., who made a chemical analysis of a small portion of the bottom-hole sample, also is gratefully acknowledged.

The author is indebted to H. H. Power of the Gypsy Oil Co., Eugene A. Stephenson of the Missouri School of Mines and Metallurgy, M. L. Haider of the Carter Oil Co., Donald L. Katz of the Phillips Petroleum Co., and R. A. Cattell, H. C. Fowler, E. S. Burnett, E. L. Rawlins, H. C. Miller, William B. Berwald, and C. K. Eilerts, all of the Bureau of Mines, for constructive criticism of the manuscript. Other members of the Bureau of Mines to whom acknowledgment is due include Peter Grandone, who did much of the laboratory work; H. A. Buss, instrument maker, whose skillful workmanship on the bottom-hole sampler and many of the instruments used in the laboratory contributed largely to the success of the experiments; and James M. Seward, who prepared the illustrations.

SUMMARY OF RESULTS

The following table presents some of the more important data resulting from the experiments, computations, and estimates discussed later in the report. In connection with these

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[1] Published by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.)

[2] The experimental work reported in this paper was performed by or under the supervision of Ben E. Lindsly while a Senior Petroleum Engineer at the Bureau of Mines Petroleum Experiment Station, Bartlesville, Oklahoma. After Lindsly transferred from the Bureau of Mines on November 5, 1934 to accept the position of Chairman of the Technical Advisory Committee, Petroleum Administrative Board, Department of the Interior, the manuscript he had submitted in August, 1934 was augmented and completed by R. A. Cattell, chief engineer, Petroleum and Natural-Gas Division, Bureau of Mines, with assistance from C. K. Eilerts of the Bureau of Mines, Petroleum Experiment Station, Bartlesville, Oklahoma.

[3] Lindsly, Ben E., A Study of "Bottom-Hole" Samples of East Texas Crude Oil: Rept. of Investigations 3213, Bureau of Mines, May 1933, 17 pp.

data it should be mentioned that the reservoir oil seems to have been saturated with lighter hydrocarbons, with the result that some gas was liberated from the oil as it flowed to the well under the influence of the differential pressure between the reservoir and the bottom of the hole. Therefore, data relating to "reservoir fluid" necessarily differ somewhat from those relating to the "bottom-hole sample."

Data relating to well and bottom-hole sample:

Bottom-hole pressure with well shut in . 2829 lb./in.^{2} abs.
Bottom-hole temperature with well shut in . . 149°F.
Depth of well[4] . . . . . 6141.5 ft.
Sample taken at depth of . . . . . 6100 ft.
Volume of sample . . . . . 1000 cc.
Saturation pressure (pressure at which gas begins to evolve from the oil) of sample at 149° F. . . . . 2575 lb./in.^{2} abs.
Saturation pressure of sample at 70° F. . 2050 lb./in.^{2} abs.

While the well was flowing at the rate of 18 bbl. of residual oil (oil measured at the surface after liberation of gas) per hour just before it was shut in for sampling the measured wellhead pressure was 894 lb./in.^{2} abs., and the bottom-hole pressure at that time is estimated to have been 2575 lb./in.^{2} abs. Since there was ample time for equalization of pressure and temperature in the sand surrounding the well during the interval between closing of the well and the measurement of the bottom-hole pressure of 2829 lb./in.^{2} abs. and the bottom-hole temperature of 149° F., these values are used in the report in the reservoir pressure and temperature.

Gravities and weight of bottom-hole oil at reservoir pressure and temperature, determined from pressure traverse of well when shut in[5]

Specific gravity of bottom-hole oil 0.736
A.P.I. gravity of bottom-hole oil . . . . . 60.8°
Weight of bottom-hole oil . . . . . 6.13 lb. per gal.
45.8 per cu. ft.
257 lb. per bbl.
Pressure per 100-ft. head of bottom-hole oil . 31.9 lb./in.^{2}

Analysis of "bottom-hole" sample[6]

Hydrocarbon	*Mol Fraction*	*Weight Fraction*
Methane, CH_4 . . .	0.3290	0.0519
Ethane, C_2H_6 . . .	.1489	.0440
Propane, C_3H_8 . . .	.0393	.0171
Butane, C_4H_{10} . . .	.0375	.0215
Pentane, C_5H_{12} . . .	.0279	.0198
Hexane, C_6H_{14} . . .	.0358	.0304
Residue	.3816	.8153
	1.0000	1.0000

Specific gravity of residue . . . . . 0.840 at 60° F.
Molecular weight of residue . . . . 217 (observed)
Calculated gravity of sample . . 0.705 (69.2° A.P.I.) at 2900 lb./in.^{2} and 60°F.

Gas liberated from bottom-hole sample during reduction from saturation pressure to atmospheric pressure.

(All gas volumes reduced to 70° F. and 14.4 lb./in.^{2} abs.)

By isothermal differential liberation[a] at 149° F.:
814 cu. ft. of gas per bbl. of residual oil measured at 2829 lb./in.^{2} abs. and 149° F.:
579 cu. ft. of gas per bbl. of initial fluid (estimated).

By isothermal differential liberation at 70° F.:
665 cu. ft. of gas per bbl. of residual oil.
530 cu. ft. of gas per bbl. of initial fluid measured at 2829 lb./in.^{2} abs. and 70° F. (estimated) equivalent to
508 cu. ft. of gas per bbl. of initial fluid measured at 2829 lb./in.^{2} abs. and 149° F.

By isothermal flash liberation[b] at 149° F. (estimated):
1066 cu. ft. of gas per bbl. of residual oil.
701 cu. ft. of gas per bbl. of initial fluid.

By isothermal flash liberation at 70° F. (estimated):
630 cu. ft. of gas per bbl. of residual oil.
508 cu. ft. of gas per bbl. of initial fluid measured at 2829 lb./in.^{2} abs. and 70° F., equivalent to
487 cu. ft. of gas per bbl. of initial fluid measured at 2829 lb./in.^{2} abs. and 149° F.

Liberation of gas from reservoir fluid (estimated)

By isothermal differential liberation from 2829 lb./in.^{2} abs. to atmospheric pressure, at 149° F.:
887 cu. ft. of gas per bbl. of residual oil.
617 cu. ft. of gas per bbl. of initial fluid.

By isothermal flash liberation from 2829 lb./in.^{2} abs. to atmospheric pressure, at 149° F.:
1144 cu. ft. of gas per bbl. of residual oil.
736 cu. ft. of gas per bbl. of initial fluid.

By flash liberation from 2829 lb./in.^{2} abs. to atmospheric pressure with temperature falling gradually from 149° to 70° F.:
698 cu. ft. of gas per bbl. of residual oil.
527 cu. ft. of gas per bbl. of initial fluid.

Shrinkage of liquid in bottom-hole sample upon reduction from 2829 lb./in.^{2} abs. to atmospheric pressure, percent

By isothermal differential liberation at 149° F. . . . 28.8 (observed)
By isothermal differential liberation at 70° F. . . . . 20.2 (observed)
By isothermal flash liberation at 149° F. . . . . 34.3 (estimated)
By isothermal flash liberation at 70° F. . . . . 19.4 (estimated)

The 149° F. values are based on measurement of the initial fluid at 2829 lb./in.^{2} abs. and 149° F. and measurement of the residual oil after it had cooled at atmospheric pressure from 149° to 70° F. The 70° F. values are based on measurement of the initial fluid at 2829 lb./in.^{2} and 70° F. and measurement of the residual oil at atmospheric pressure and 70° F.

Estimated shrinkage of liquid in reservoir fluid upon reduction from 2829 lb./in.^{2} abs. to atmospheric pressure, percent

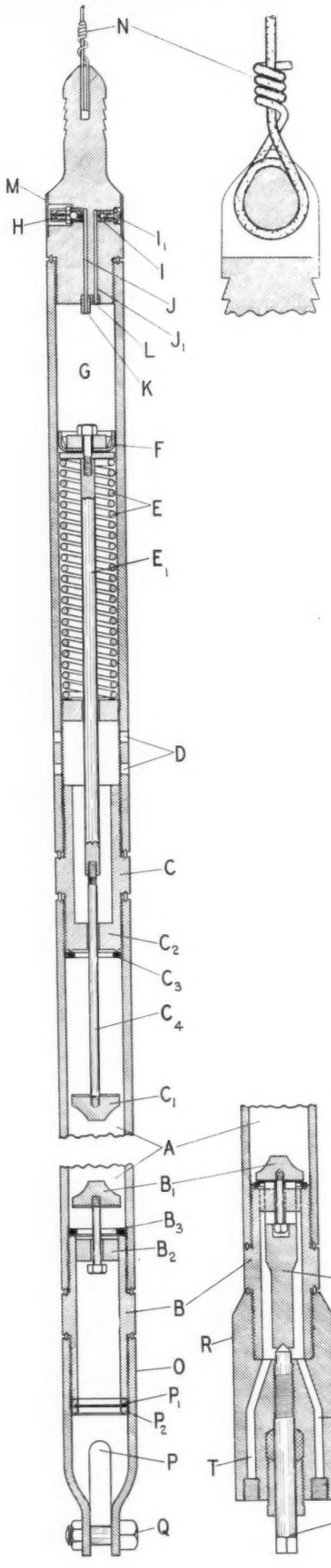
By isothermal differential liberation at 149° F. . . 30.5
By isothermal flash liberation at 149° F. 35.7
By flash liberation with temperature falling gradually from 149° to 70° F. 24.6

These values are based on measurement of the initial fluid at 2829 lb./in.^{2} abs. and 149° F. and of the residual oil at atmospheric pressure and 70° F.

[4] Determined by C. V. Sidwell of the Amerada Petroleum Corporation and Dave Collins of the Gypsy Oil Co.
[5] Pressure traverse by C. V. Sidwell of the Amerada Petroleum Corporation and Dave Collins of the Gypsy Oil Co.
[6] Analysis by Donald L. Katz, Phillips Petroleum Co., Bartlesville, Okla.

[a] "Differential liberation" is defined as liberation in which the gas is removed from contact with the liquid as it is liberated.
[b] "Flash liberation" is defined as liberation in which the evolved gas remains throughout the process in intimate contact with the liquid from which it was released.

Fig. 1. Diagram of "bottom-hole" sampler.



Pressure-volume and energy relations (flash liberation)

For 1 cu. ft. of bottom-hole sample measured at 2829 lb./in.² abs. and 149° F. (45.8 lb. of fluid) expanding isothermally at 149° F.:

Pressure (and corresponding position during flow at 18 bbl./hr.) P, lb./in.² abs.	Volume V, cu.ft.	Indicated work of fluid[c] (by graphic integration), $144\left[P_1V_1 - P_2V_2 + \int_{V_1}^{V_2} P\,dV\right] = -144\int_{P_1}^{P_2} V\,dP$ ft-lb.
2829 (reservoir)	1.0000	
to	to	36,600
2575 (bottom-hole)	1.0025	
to	to	310,400
894 (wellhead)	1.94	
to	to	1,097,800
14.4 (atmospheric)	144.1	
	Total	1,444,800

Work of lifting 45.8 lb. 6100 ft. . . . . 279,400 ft-lb.

For 1 cu. ft. of reservoir fluid measured at 2829 lb./in.² abs. and 149° F. (45.2 lb. of fluid):

	Isothermal expansion at 149° F.		Expansion with temperature falling gradually from 149°F. at 2829 lb./in.² abs. to 70°F. at 14.4 lb./in.² abs.	
Pressure, lb./in.² abs.	Volume, cu. ft.	Indicated work, ft-lb.	Volume, cu. ft.	Indicated work, ft-lb.
2829	1.000		1.000	
to		37,200		37,000
2575	1.032		1.025	
to		324,700		305,300
894	2.06		1.83	
to		1,172,900		882,300
14.4	151.4		95.1	
	Total 1,534,800		Total 1,224,600	

Work of lifting 45.2 lb. 6100 ft. . . . . 275,700 ft-lb.

DESCRIPTION OF BOTTOM-HOLE SAMPLER

Fig. 1 is a diagram of the apparatus used for obtaining a sample of oil from the bottom of the well. The apparatus consists of three principal parts: (1) The barrel, A, which is approximately 3½ ft. long, (2) the upper valve mechanism, and (3) the lower valve mechanism. The assembled apparatus is approximately 6 ft. long and 1¾ in. outside diameter. The laboratory head, R, which is attached to the sampler when it is taken to the laboratory after obtaining a sample, provides a means for withdrawing oil from the bottom-hole sampler.

C is the upper valve cage; C_1, a knife-edge valve, which forms a tight seal with valve seat C_3 and C_2, a centrally-located guide for valve stem C_4. Piston rod E_1 connects valve stem C_4 with cup-leather piston F. Spring E provides the actuating force that closes valve C_1. Before the sampler is lowered into the well spring E is compressed about 2½ in. by pumping lubricating oil of high viscosity into cylinder G through a grease-gun fitting, H, on oil-inlet port J. Orifice I restricts the flow of oil through outlet port J_1. Finemesh screen L at the lower end of port J_1 prevents particles of dirt from clogging orifice I. I_1 is a screw plug that prevents oil from escaping from cylinder G. When the instrument is ready for lowering into a well screw plug I_1 is removed, and valve C_1 rises and eventually closes as the slow action of spring E expels oil from cylinder G through orifice I.

[c] "Indicated work of fluid" will be discussed and defined more fully later on.

Loose-fitting protector sleeve M prevents sand and scale from entering grease-gun fitting H and orifice I. The type of hitch used in tying the sampler to the wire line is shown at N. Tests by Lindsley, Jones, and Lisk[7] have shown that this type of hitch withstands loads exceeding 700 pounds.

Lower valve cage B, valve B_1, valve seat B_3, and guide B_2 are similar to the corresponding parts C, C_1, C_3, and C_2 of the upper valve assembly. The lower valve, however, closes by its own weight. Footpiece O is fitted with screens P_1 and P_2. Port P permits fluid to enter the sampler while it is being lowered into a well. Q is a bolt for attaching a bomb for obtaining the temperature, pressure, or both. Screw U and plunger S in laboratory head R may be used to open valve B_1.

At 132° F. about 34 minutes is required to expel the pumped-in lubricating oil from cylinder G. Therefore, when the bottom-hole temperature is about 132° F. the sampling operation is planned so the desired sample will be in the sampler within 34 minutes after the removal of screw plug I_1. Appropriate adjustments in time, based on calibration, are made when sampling is done at bottom-hole temperatures higher or lower than 132° F. In actual practice, however, the time required to close valve C_1 is greater than that indicated by the calibration, because at least 20 minutes is required for the sampler and the oil in cylinder G to assume the bottom-hole temperature. Before this temperature is reached the closing motion of valve C_1 is slower than the calibrated value because of the greater viscosity of the oil in cylinder G at lower temperatures. To overcome uncertainties in obtaining a correct sample the practice has been adopted of allowing the sampler to remain at the bottom of the well for at least one hour. The required time would be shorter if a less viscous oil, a larger orifice, or a more powerful spring were used.

Since completion of the field work in the Crescent pool discussed in this report, an alternate method of closing valve C_1 has been developed in the laboratory. Instead of the viscous lubricating oil formerly used, a grease mixture of suitable viscosity is pumped into cylinder G. This modification permits use of a much larger orifice at I and thereby largely eliminates uncertainties due to clogging of the orifice with minute particles. A suitable grease may be obtained and compounded, with or without admixture of small quantities of lubricating oil, to give any desired viscosity within the range of bottom-hole temperatures.

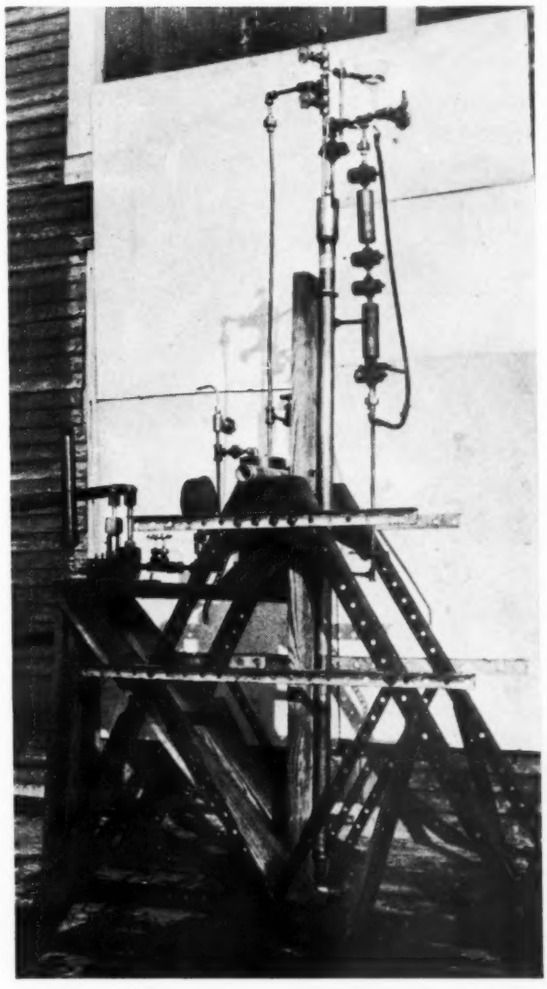


Fig. 2. Bottom-hole sampler mounted and connected for transferring oil into high-pressure laboratory bombs by mercury displacement.

METHOD OF SAMPLING

If the oil in the reservoir is saturated with gas-forming constituents and the object of the bottom-hole sampling is to obtain a sample closely resembling the oil in the formation the loss of pressure as the fluid flows through the sand to the bottom of a well and the resulting liberation of gas have an important bearing on the method used in taking the sample. Shutting in a flowing well and allowing the pressure at the bottom to build up to the reservoir pressure do not assure that the gas liberated from the oil as it moved through the sand to the bottom of the well will be reabsorbed. Much of the gas liberated from the oil passes through the column of fluid in the well and accumulates under pressure in the upper part of the casing; moreover, although some of the liberated gas remains with the oil there may be insufficient commingling and agitation to reabsorb it. In consequence, therefore, even with a prolonged shut-in period and full reservoir pressure it is impossible for all the gas that escaped from the oil upon reduction of pressure to be reabsorbed into the liquid.

For these reasons, in a field where the reservoir oil is saturated with the lighter hydrocarbons a bottom-hole sample taken after a well has been shut in and the pressure allowed to build up will contain a smaller quantity of gas-forming constituents than oil at the same pressure within the reservoir. The degree of undersaturation of the sample depends mainly upon the rate of production before sampling. If the well has been producing at a high rate, so that the bottom-hole pressure was considerably less while the well was flowing than when it was shut in, the sample may be greatly undersaturated. Consequently, prior to sampling it is desirable to flow the well for several hours at the lowest rate at which steady flow can be maintained. Under such conditions, oil will flow from the sand to the bottom of the well with comparatively little loss in pressure. During the flow that preceded the taking of the sample discussed in this report the "bottom-hole" pressure was 200 to 250 lb./in.^{2} lower than the reservoir pressure.

In preparing the sampling apparatus for taking a bottom-hole sample it is preferable to charge cylinder G (fig. 1)

[7]Lindsly, Ben E., Jones, Dan L., and Lisk, Robt. C., Wire Line Ties for Bottom-Hole Instruments Are Studied by U. S. Bureau of Mines Engineers: *Oil and Gas Journal*, August 17, 1933, p. 9.

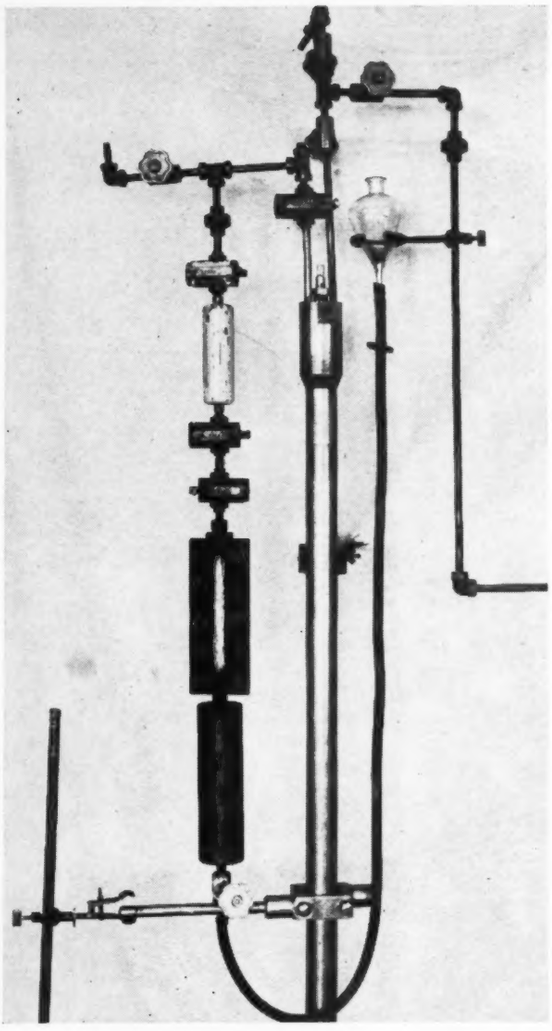


Fig. 3. Bottom-hole sampler with laboratory head R and connections for transferring oil into laboratory bombs by mercury displacement.

with lubricating oil indoors away from dust and dirt. After the air in cylinder G is allowed to escape through orifice I, screw plug I_1 is inserted during the remainder of the charging operation to prevent escape of oil through outlet port J_1. The screw plug is removed just before the sampler is lowered into the well.

The sampler is introduced into the well through a lubricator and suspended within the flow string on a line which passes through a stuffing box at the wellhead. This line is reeled out to lower the sampler at a rate of about 600 ft. per minute to the depth at which the sample is to be taken. This depth should be as close as practicable to the producing horizon but far enough above the bottom of the well to eliminate danger of drawing loose sand and silt into the sampler. While the sampler is being lowered the impact of the liquid in the well opens valve B into the position shown in fig. 1, and a stream of oil flows through barrel A, valve seat C_3, ports (not shown) in guide C_2, and thence outside the sampler through ports D. Large areas of ports and screens and ample clearance around valves have been provided to allow free flow of oil through the sampler.

After the sampler has reached its lowest position (6100 ft. in the present instance), the oil within it probably is not identical with that outside. Possibly the sample chamber still contains a small part of the oil that entered it several hundred feet up the hole. Therefore, to purge the sampler of this oil it is bobbed up and down through a vertical distance of about 25 ft. some 25 or 30 times. In bobbing the sampler the down stroke is made as rapidly as practicable so the impact on valve B_1 will open it, causing bottom-hole oil to enter the sampler and force any other oil through the upper valve and ports D. After one hour has elapsed for closing the upper valve the sampler is brought to the surface.

LABORATORY PROCEDURE

Transferring Sample to Laboratory Bombs

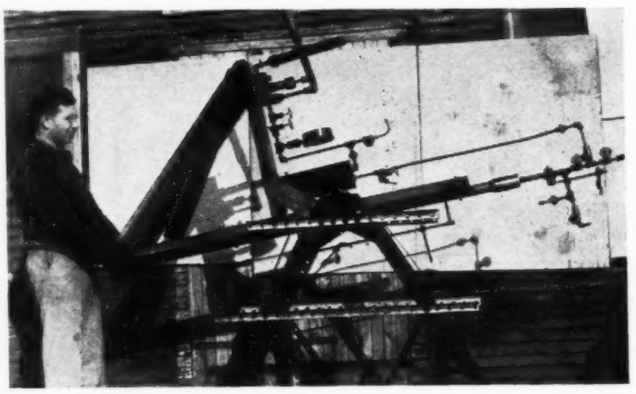
The laboratory procedure for transferring the sample is similar to that previously described by the writer[8]. The sampler is mounted in an inverted position on a frame, as shown in fig. 2, and footpiece O (fig. 1) is replaced by head R. After a mercury pump, with gage, and a top manifold for filling laboratory bombs have been connected to the head (figs. 2, 3, and 4) pumping of mercury is begun.

When the mercury has displaced the air in the head, manifold, and piping a valve on the manifold is closed, and pumping is continued, causing the pressure of the mercury to rise. The pressure at which the mercury overcomes the pressure within the sampler is noted, as it indicates the properties of the sample under investigation. If care is taken this pressure can be determined definitely—valve B_1 is heard to click when the pressure of the mercury causes it to open, and as soon as the valve opens mercury can be heard to drop through the oil to the bottom of the sample chamber. Since the sampler is inverted the bottom of the chamber as here referred to is its top when the sampler is upright. Mercury is pumped into the sampler until the pressure is considerably higher than reservoir pressure, thus compressing the gas that was liberated (through reduction in pressure due to cooling) when the sampler was brought from the bottom of the hole to the surface.

In the work discussed in this paper the pressure in the sampler on arrival at the laboratory was 2229 lb./in.^{2} abs. or

[8]Lindsly, Ben E., A Study of "Bottom-Hole" Samples of East Texas Crude Oil: Rept. of Investigations 3312, Bureau of Mines, 1933, pp. 5-6.

Fig. 4. Bottom-hole sampler and assembly in position for "rocking."



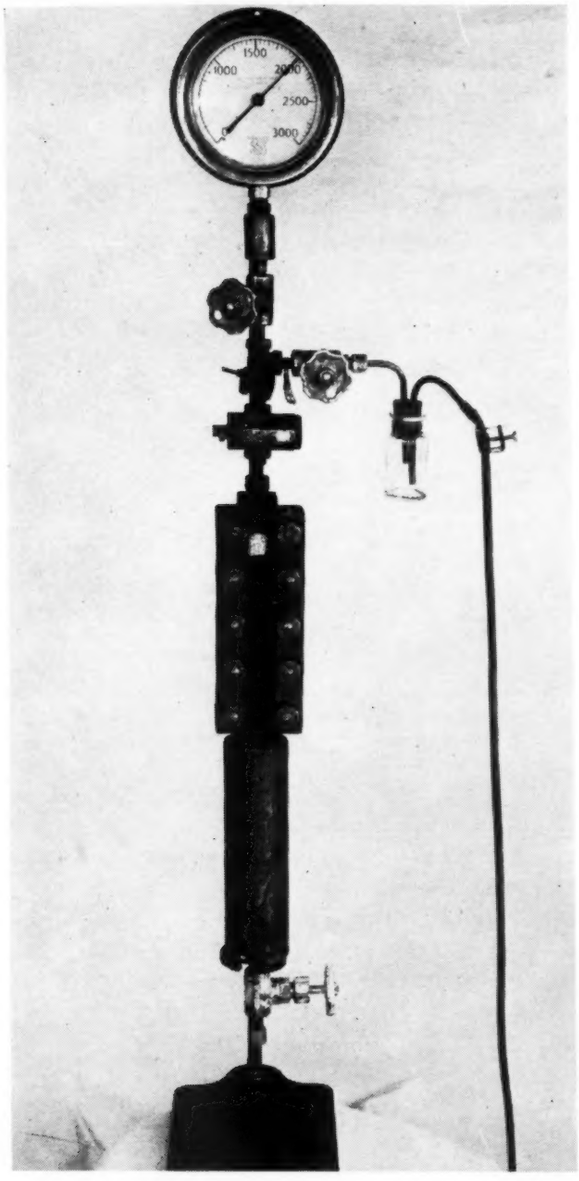


Fig. 5. Assembly of laboratory bomb and liquid-level gauge used in differential liberation for determining saturation pressure, shrinkage, and volume of gas liberated.

600 lb. lower than the reservoir pressure. In view of a difference of approximately 70° F. between the reservoir and atmospheric temperature a pressure reduction of this magnitude is not surprising, as contraction of the oil due to temperature change has a marked effect upon the pressure in the sampler. Had it not been for the gas liberated from the sample the pressure probably would have dropped from nearly 3000 lb./in.^{2} to less than atmospheric.

When a pressure considerably above reservoir pressure is attained the pumping of mercury is discontinued temporarily, the valves between the mercury pump and the sampler are closed, and the contents of the sampler are agitated to reabsorb the gas liberated from the oil due to the reduction of temperature. Agitation is accomplished by "rocking" the entire assembly, including the bottom-hole sampler, mercury pot, and pump. To facilitate rocking the assembly is mounted on trunnions which rest on a steel frame. Fig. 4 shows the assembly in a nearly horizontal position. A slight motion up and down causes the mercury in the sampler to travel from one end to the other of the sample chamber and the free gas to travel in the opposite direction. Agitation of some oils with mercury will cause formation of mercury-oil emulsions, but no difficulty of this nature was experienced with the Crescent pool oil.

The sample usually is rocked for at least 5 minutes or until mingling of the free gas and the oil causes the gas to become completely absorbed in the oil, as evidenced by maintenance of the same pressure before and after rocking intervals. Small laboratory bombs filled with mercury then are connected to the top manifold (figs. 2 and 3), and by proper manipulation of the valves and mercury pump the mercury in the laboratory bombs is displaced by oil from the sampler without loss of pressure or liberation of gas. These bombs then contain bottom-hole oil virtually identical with that at the bottom of the well at the time of sampling, but under a greater pressure and at a lower temperature. The laboratory bombs for determining saturation pressures and for certain experiments relating to differential liberation of gas have a high-pressure liquid-level gage attached, as shown in fig. 5. Such a bomb and the connected liquid-level gage are filled as a unit by the method described above (fig. 3). Before a portion of the original sample contained in a laboratory bomb is used in an experiment it is stabilized at the desired temperature and pressure, as described under the next subheading.

Perhaps it is natural to assume on first thought that when the charged bottom-hole sampler is brought to the laboratory the initial step would be to immerse it in a bath maintained at bottom-hole temperature, allow the sample to reach the temperature of the bath, and then determine the pressure within the sampler. However, since there is a slight stretch in the walls of the sampler when subjected to unbalanced internal pressure it would be necessary, if bottom-hole conditions are to be duplicated, to have the bath at bottom-hole pressure.

If the contents of the sampler could be brought to bottom-hole temperature and volume without mishap the measured pressure of the sample would serve as a check against bottom-hole pressure determinations by other methods; or, if other measurements of bottom-hole pressure are considered to be correct the pressure within the sampler would constitute evidence as to whether there had been leakage from the sample after it was raised from the bottom of the well. However, the writer has not attempted such procedure because of certain difficulties that perhaps are not readily apparent to those without first-hand experience in handling liquids under high pressure that completely fill their container. The liberation of gas from the oil as the temperature is reduced in removing the sampler from the well, the difficulty of reabsorbing this gas at the required rates as the sampler is brought back to bottom-hole temperature, the excessive pressures that would be developed if all the gas were not reabsorbed, the elastic properties of the walls of the sampler, and uncertainties in determining bottom-hole temperatures all enter the problem.

To meet and overcome the difficulties suggested above would complicate the apparatus and procedure, increasing the risk of spoiling the sample through leakage. Where samples are obtained easily this is not a serious objection. In the present instance, however, on account of proration rul-

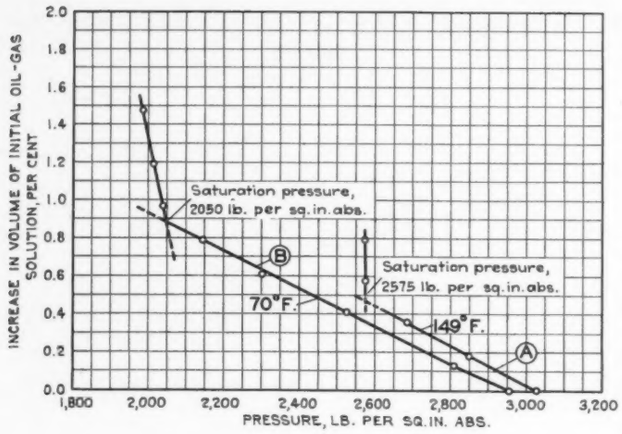


Fig. 6. Determination of saturation pressure.

ings, if the sample had been lost a delay of at least 30 days would have resulted. In the opinion of the writer, until the laboratory apparatus and technique for examining bottom-hole samples and the methods of determining bottom-hole temperatures are developed to a finer degree it is inadvisable to attempt to bring the entire sample and sampler back to bottom-hole conditions. Instead, parts of the original sample are brought to bottom-hole pressure and temperature in the laboratory bombs.

Stabilizing Laboratory Samples at Definite Pressure and Temperature

In each instance the laboratory bomb containing the sample of oil (portion of the original bottom-hole sample) is brought to the temperature and pressure desired for the experiment to be performed by the following procedure: A manifold with a pressure gage attached is connected to the closed stopcock at the top of the bomb, the manifold and pressure gage are evacuated, a light-grade lubricating oil is pumped through the outlet valve of the manifold into the evacuated space at a pressure equal to that within the bomb, and the outlet valve of the manifold is closed. The stopcock between the bomb and pressure gage is then opened, the bomb is placed in a water bath maintained at reservoir temperature (or other temperature if desired), and as the pressure in the bomb rises due to the increasing temperature some of the liquid content of the manifold is withdrawn. Finally, when the temperature of the bomb and its contained liquid becomes constant the pressure is reduced slowly and stabilized at the desired value by withdrawing oil from the outlet valve of the manifold.

The liquid in the laboratory bomb expands as oil is withdrawn from the outlet valve of the manifold to prevent the increase in temperature from causing an excess pressure, and the contact between the sample and the lubricating oil rises in a pipe of small cross-sectional area; therefore the sample is not contaminated by the oil placed in the manifold. The term "bomb" as used under this heading includes both the bomb proper and the liquid-level gage in instances where an assembly like that shown in fig. 5 is employed.

Determination of Saturation Pressure

Determination of the saturation pressure consists essentially of decreasing the pressure on a sample of the bottom-hole oil which completely fills its container and noting that at which gas begins to be liberated. The container consists of a laboratory bomb with a liquid-level gage attached, as shown in fig. 5. When oil is transferred from the bottom-hole sampler to this container a small amount of mercury is allowed to remain in the bottom of the laboratory bomb.

The contents of the bomb and liquid-level gage are stabilized at the desired temperature and pressure, as previously explained, with oil under liquid compression filling all space above the mercury. The pressure then is reduced gradually by the release of small amounts of mercury through the bottom valve. At first a marked decrease of pressure results from the withdrawal of each small quantity of mercury; eventually, however, a condition is reached where the release of additional mercury has only a slight effect upon the pressure within the bomb, indicating that a gaseous phase has appeared. From then on, with further withdrawal of mercury, gas liberated from the oil tends to maintain the pressure. The increase in volume of the fluid within the container, corresponding to each decrease in pressure, is determined by measuring the volume of the mercury withdrawn.

The apparatus is removed from the constant-temperature bath for mercury withdrawal and returned to the bath as rapidly as practicable to prevent reduction of pressure and liberation of gas through thermal contraction. To prevent cooling under these circumstances it has been decided in future tests to enclose the entire apparatus (except the lower valve and the pressure gage) in a rubber boot made from the inner tube of an automobile tire. With this arrangement the temperature will be more nearly maintained, because the apparatus will be surrounded by water at bottom-hole temperature even when removed from the bath.

Fig. 6 shows the percentage increases in volume of the sample plotted as ordinates against the pressures as abscissas. The intersection of the lower part of curve A, fig. 6, which represents liquid expansion, with the upper part of the curve, where gas expansion is the predominant effect, is at 2575 lb./in.^{2} abs., when the temperature is maintained at 149° F. Similarly, curve B, which represents the experiment conducted at 70° F., shows the saturation pressure to be 2050 lb./in.^{2} abs.

Referring to curve A, the difference between the saturation pressure (2575 lb./in.^{2} abs.) and reservoir pressure is 254 lb./in.^{2} This difference cannot be attributed to undersaturation of the reservoir oil, because flow tests conducted by Sidwell and Collins[9] indicate that at the rate the well was flowing before it was shut in for sampling the bottom-hole pressure was 200 to 250 lb./in.^{2} lower than the reservoir pressure. Gas in excess of that required to saturate the oil at the flowing bottom-hole pressure must have escaped from the reservoir fluid and passed through the oil column to the top of the casing before the bottom-hole pressure built up to reservoir pressure after the well was shut in for sampling. It is thought, therefore, that the 254 lb./in.^{2} undersaturation of the sample can be attributed to the loss of gas from the oil when the bottom-hole pressure was reduced by flowing and that the bottom-hole pressure during flow was about 2575 lb./in.^{2} abs.

[9]Sidwell, C. V., Amerada Petroleum Corporation, Tulsa, Okla., and Collins, Dave, Gypsy Oil Co., Tulsa, Okla.

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A "60" Caterpillar bulldozer in action. During late December and in January this type equipment had to be used for backfilling almost entirely due to the frozen condition of the ground. On the remainder of the job Model D Buckeye backfillers were employed

Construction of Pipe Line Outlet for Central Michigan Crude

By NORMAN X. LYON

Line from Crystal field to Toledo, Ohio, completed in 60 working days despite difficulties encountered in the form of swamps, heavy snowstorms, rains, etc. — One pumping station constructed.

CONSTRUCTION of the first interstate crude oil trunk pipe line as an outlet for Central Michigan fields presented a number of interesting problems. The 8-in. line has its Michigan terminal at Crystal field, Montcalm County, approximately 30 miles south of Mt. Pleasant, and extends in a southeasterly direction 140 miles to Toledo, Ohio, to the Standard Oil Company of Ohio's refinery. Approximately ten miles of the line is in Ohio, the rest in Michigan.

The line was constructed for and will be operated by the Michigan-Toledo Pipe Line Company, a company incorporated by the Simrall Pipe Line Company of Mt. Pleasant and the Standard Oil Company of Ohio.

Until now Michigan independent carriers have not been in a position to compete with Mid-Continent crude on the Toledo and Ohio refining market because of freight differentials built up by shipments either by railroad tank cars or by lake tankers. As a result shipments to Toledo have been comparatively restricted.

Construction of the line also marks the Standard's first active participation in Michigan as a carrier and as a buyer of crude oil.

The general construction contract was awarded to the Franklin Tool Company of Mt. Pleasant for the 130 miles from the Crystal terminal to the Ohio-Michigan line. Coolsaet Brothers of Dearborn, Michigan, were given the contract for the remainder of the line, most of which was within the city limits of Toledo.

The deal to construct the line was closed on October 1, and, to any contractor in Michigan, October sounds a warning note, as weather conditions from that time on to June at the best cannot be depended upon.

An air survey was made of the proposed route prior to the obtaining of the right-of-way. The latter was accomplished in the rapid time of 46 working days. Cost of right-of-way was estimated at from 28 cents to 35 cents per rod for the entire route. In addition to obtaining right-of-way from individual property owners it was necessary to have permits from eight different county highway boards and for nine railroad crossings. Except for 11 miles on the south end of the right-of-way goes cross country. On that 11 miles the pipe line right-of-way follows that of the Ann Arbor Railroad Company into Toledo.

The Franklin Tool Company, upon being awarded the general construction contract on October 14, immediately started moving in equipment, dividing construction crews into two gangs, one starting at the north end or Crystal terminal and the other at the Michigan-Ohio line to work north. Heavy equipment was moved in by truck and railroad flat cars, contractors having the advantage of good highways and railroad connections most of the route.

Due to the fact that the line survey either went through or close to either cities or fair-sized towns at intervals of not more than 20 miles and frequently less, it was not necessary to establish field construction camps for employees. Field offices were maintained first at Mt. Pleasant, later at St. Johns, Lansing, Chelsea, Milan, etc., as work progressed.

All new pipe was used, 8⅝-in. O.D., 24.69-lb. seamless. The pipe purchase was split among three companies as fol-

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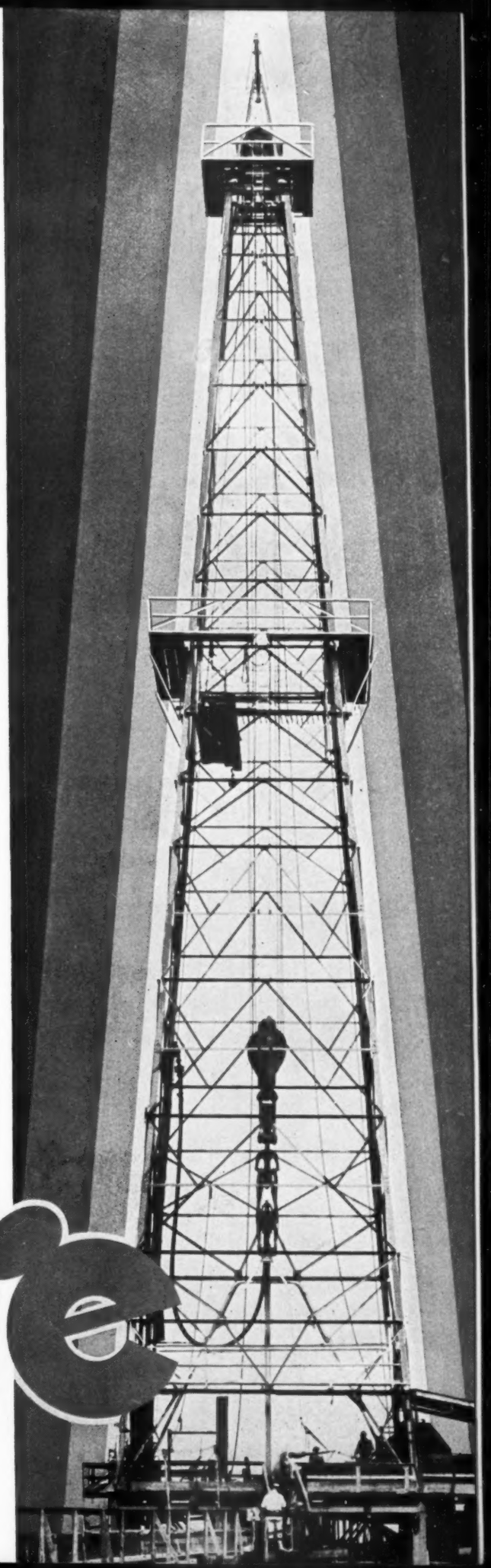

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lows: 20 miles of Youngstown seamless; 60 miles of Republic Electric Weld; and 60 miles of National Tube Seamless.

Pipe stringing most of the way was accomplished with trucks having rear-end hoists and drag lines, "Cats" augmenting the equipment in the areas of especially tough "going." Pipe was shipped in by railroad flat cars to convenient unloading spots at Carson City, St. Johns, Lansing, Okemos, Chelsea, Stockbridge, Bridgewater, Dundee, and Toledo. This cut down the distance of truck hauls to a few miles and enabled comparatively fast stringing.

Both the north and south gangs started actual construction on November 1, with the intervening time from October 14 required to get equipment on the ground and map the full program so that delays would not be likely to occur later. This proved its value later when the final tie-in was made on January 25, with the exception of a 4-mile strip where it was necessary to detour Ford property near Milan, which was completed two weeks later. The 140-mile line was completed, including river and railroad crossings, in 60 days working time.

Two Model "32" Buckeye ditchers were put in service at both the north and south ends at the start. A 32-36 in. ditch was dug, 18 in. width, all of which, with the exception of approximately 20 miles, was ditched with machines. The ditchers averaged from three-fourths to a mile each per 24-hour day except in the marsh areas and during the last work in January.

Weather conditions all in all favored the contractors, with the exception of early November and late in January. At the outset heavy rains occurred, forcing ditchers either to go around swamps or run chances of bogging down. By December frost had extended to eight inches in the ground and on the last five miles of the line it averaged 18 inches. On the final three miles it was necessary to drill the right-of-way at intervals of every few feet with a pavement buster and dynamite before the trench could be made. The last 15 days of construction was in the face of heavy snow storms, with two bulldozer "Cats" in service almost continually to plow outside roads.

With regard to the ditching, the greatest obstacles to be overcome were the numerous marshy areas encountered, and those that were spotted with gravel and huge boulders, as well as districts containing heavy clay.

East of Lansing the line passed through the "Chandler swamp," across which a ditch was cut for approximately four miles. At Pleasant Lake the line had to be dug through another three-mile swamp. Smaller swamps, from a few rods to a quarter mile in width, occurred on an average of two to a mile over the entire route.

During any period except extreme winter it would be impossible to get either light trucks or "Cats" into the Chandler Lake swamps, since most of the time they are covered with water and a man's own weight will bog him down to his knees. Both swamps were penetrated following heavy freezing periods and it was possible to use the ditchers most of the way. One bogged down in the Chandler swamp and three days were spent in recovering it. Even during the frozen weather it was necessary to build roads from swamp brush and saplings to prevent bogging.

While the summer months would have permitted easier ditching for the most part, the swamps likely would have delayed construction in the long run if they had had to have been ditched by hand and pipe pulled into position by long drag lines.

Placing a four-joint section of pipe on skids above the trench

Except in the swamp areas, pipe was handled in this manner over the entire route

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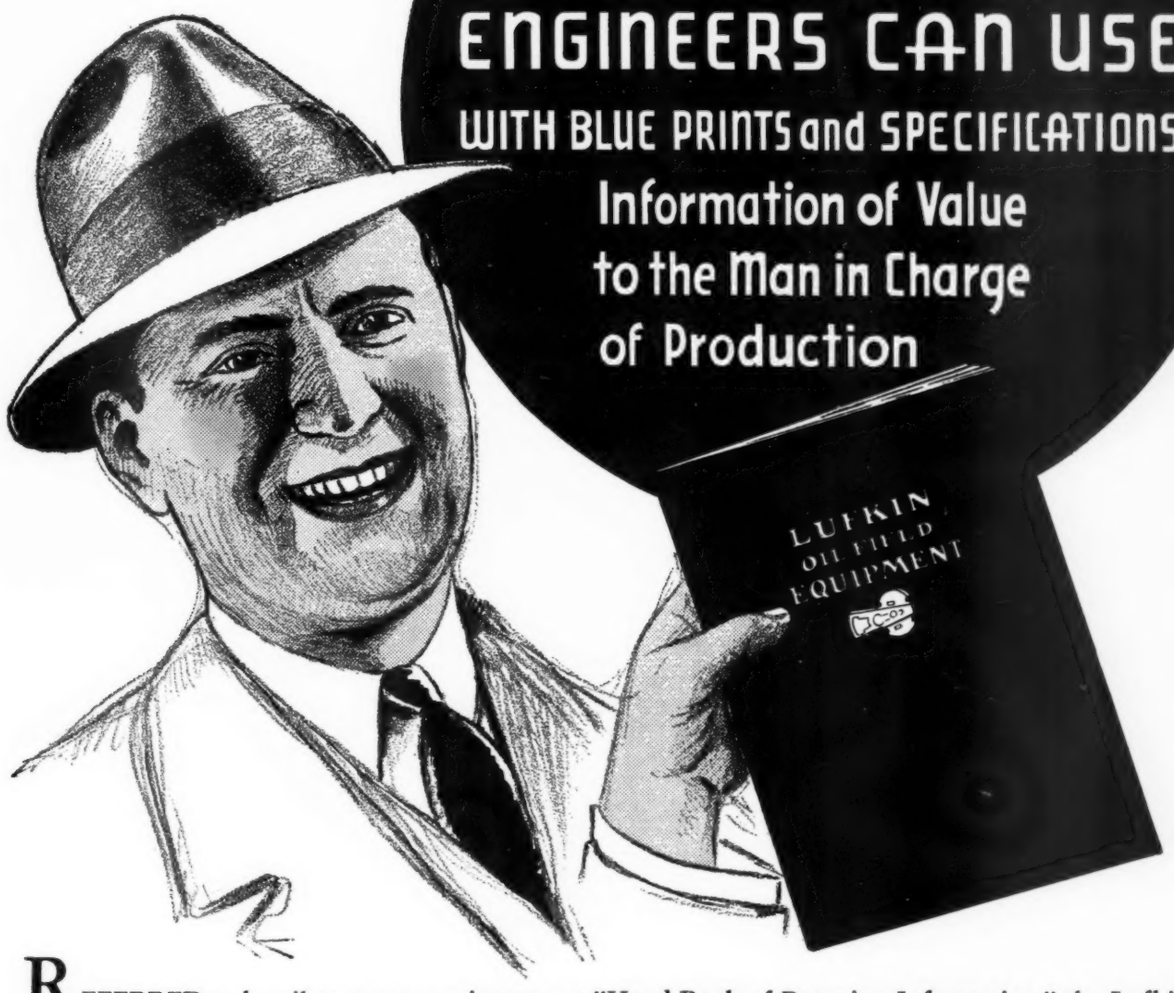

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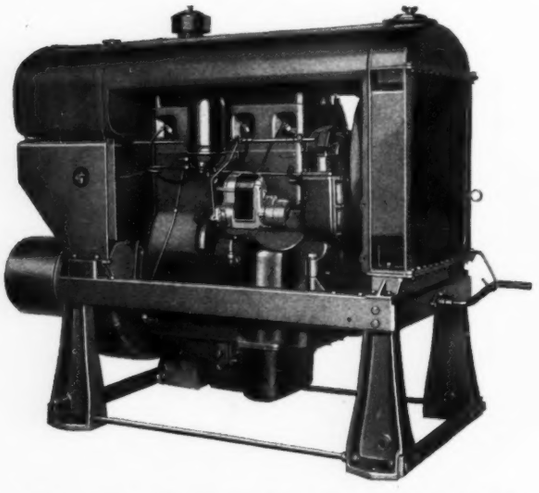

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The gravel, boulder, and clay districts east of the Irish Hills in the Jackson district also presented obstacles, but not to the extent of the bog lands. Frequently boulders weighing from a quarter of a ton to two tons were encountered a foot under the surface. These had to be dynamited or removed by hand.

A soil analysis was made at intervals over the entire length of the line, and, as a result, from Toledo north for 35 miles, the pipe was wrapped due to a sulphur condition of the soil. Factory wrapped pipe was used, employing an asphalt coating with an asbestos wrap. In the field only joints and breaks were wrapped. All river crossings also were put in with wrapped pipe, as were railroad and some of the highway crossings, depending upon the type of soil encountered.

The two firing lines averaged from two to two and one-half miles per day. Each crew included four Lindewelders and two tackers, with each welder averaging from 40 to 45 welds per eight-hour day. The best day's work was 272 welds in an eight-hour day. Pipe was in 45-ft. lengths, with an average of five joints welded into each section, although, depending upon the terrain, this varied, being as low as two and as high as seven.

The Linde Air Products Company welding process was used throughout the construction, using two welding outfits in each firing gang. This is the first line east of Chicago to be put in with the multi-flame Lindeweld head.

The pipe required little cleaning, except for scraping off frozen snow and ice, which frequently accumulated during the latter part of the job.

Equipment used included four 28 Caterpillar tractors with Cardwell booms, six McCormick-Deering 30 tractors with Seminole booms, two Model-D Buckeye backfillers, and two 60 Caterpillar bulldozers, one steam shovel, and trucks.

Fairly regular terrain was found from Crystal south approximately 50 miles, but from that point on it was highly irregular. While there were no truly mountainous areas or genuine valleys the terrain was exceedingly broken with hills, deep cuts, etc., often being encountered several times within a mile. Bends were made by the cold method.

Six river crossings were required, five of which had to be ditched by hand. The Maumme River in Ohio was the largest crossing made. Here a steam shovel on a barge was employed to dig the trench, and barges were used to carry equipment. On the smaller crossings, non-navigable rivers, only a shallow trench was needed and pipe was pulled across. The river clamps weighed approximately 500 lb. each, and from three to 15 were used, depending upon the width of the stream.

Nine railroad crossings were made, these being bored by hand. The same method was employed for the several highway crossings. At all river and railroad crossings gate valves were set on either side of the crossing.

Construction of the pumping station at Crystal was completed on January 30. The equipment includes two Worthington natural gas fueled 4-cycle, 240-hp. engines, and two Worthington duplex pumps with 6-in. bore and 18-in. stroke. The unit is capable of pumping 500 bbl. of crude per hour against 750 lb. pressure

For the present at least there will be no booster stations cut in on the line, although provision has been made for two in event it is decided later to increase the line's capacity. The present capacity is 12,000 bbl. per day.

Two 37,500 bbl. storage tanks with floating roofs have been completed at the Crystal pumping station, from which the crude is pumped to the main line. Small field pumping units are used to gather the crude from field leases.

The Crystal station adjoins the company's older station used to deliver crude through a 6-in. line to the Roosevelt Oil Company refinery at Mt. Pleasant. C. L. Maguire, president of the Roosevelt Oil Company, also heads the Simrall Pipe Line Company.

The Simrall Pipe Line Company's Michigan field gathering system now serves the Greendale and Porter fields and the Leaton-Vernon area. Four-in. and six-in. lines deliver crude to the company's Mt. Pleasant terminal and to Crystal. The company also serves the new Beaverton and the West Branch areas, although shipments from those points are made by railroad.

The company has on its prospectus the extension of a line to the West Branch field, approximately 100 miles, and a 40-mile spur off the Crystal-Toledo line east to Trenton, where the White Star Refining Company operates a large refinery.

Gene Harper, general manager of the Franklin Tool Company, was in active charge of general construction for the entire line. B. J. Davis, of the Standard Oil Company of Ohio, was chief inspector, with "Kansas" Reed inspector on the south end and "Jap" Mennis on the north. Del Hewitt, pipe line superintendent of the Simrall Pipe Line Co., supervised construction of the pumping station.

In charge of obtaining the right-of-way was A. E. Butterfield, and he had as his first aide Tommy Mast, as well as five other assistants. The air survey of the route was made by H. L. Gentry of Jackson, Michigan. The pipe stringing was done by J. C. Douding, of Flint, Michigan. Pat Mast was foreman of the firing line welders. Whitey Hughes and Bill Browning were field men for the Linde Air Products Company. C. G. Daniels was foreman over the construction crew on the north end of the line, and Logan Ingram on the south. "Nig" Simms and Frank Hampton had charge of the pipe "gangs."

The 140-mile right-of-way for the line missed some of the bad-hill districts of Michigan, but had to cut through many stretches similar to the one shown here. This view of construction is near Chelsea, Michigan, where five hills had to be crossed in a mile

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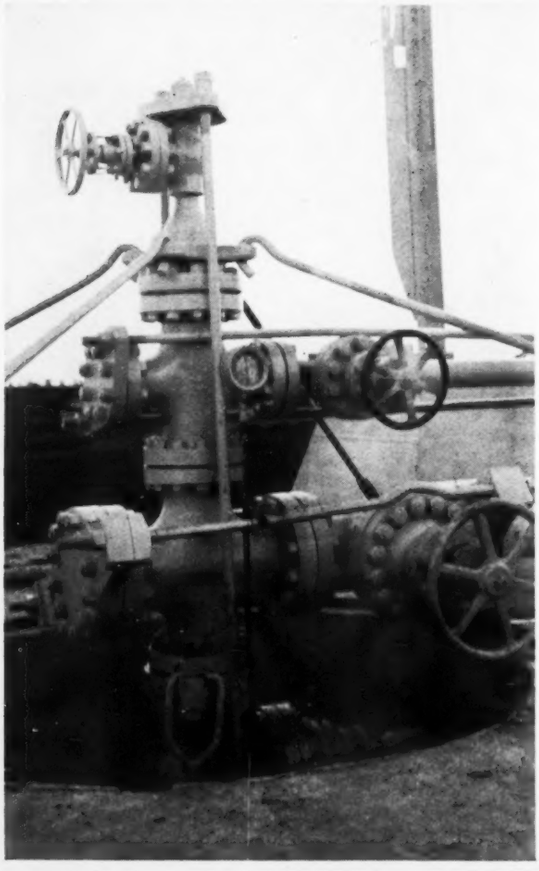

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Vacuum Equipment in the Oil Refinery

Part I

By CHARLES T. CHAVE

IN every new field, engineering begins as an art and develops into a science. The application of scientific knowledge, particularly quantitative data, to a new engineering problem results in a greater refinement and precision of design, adding to the usefulness of the process or apparatus in question.

One particular problem, which has been in a large measure neglected, is that of maintaining a vacuum in chemical apparatus, more especially in the oil distillation unit. The reason for this is that, generally speaking, vacuum-producing equipment is regarded as being in the gadget class—a necessary evil, slightly mysterious at that. When overdesigned, at slight initial cost as compared with other elements of the distillation unit, it operates with satisfaction, and no one knows the extent of the overdesigning.

When underdesigned, however, the importance of the vacuum apparatus is suddenly magnified. More than once, a set of vacuum pumps, or a barometric condenser that was wrongly selected, has caused trouble to both the refiner and the designing engineer. In the writer's experience, this underdesign of at least a part of the vacuum-producing system, combined with the wasteful but compensating overdesign of another part, is the usual thing. Barometric and jet condensers, and steam jet air pumps, were developed primarily for use in the steam power plant. Steam jet air pumps are a fairly modern development, and though much research has been made, resulting in much improvement in economy and operating characteristics, this knowledge is kept strictly guarded by only a few manufacturers. A literature search would yield the layman little of value in this connection. Barometric and jet condensers were developed for the steam engine primarily. The design data available are largely related to engine performance; the required vacuum, the amount of non-condensables to be handled, and the economy in water consumption impose far less stringent requirements on the capabilities of the apparatus than are encountered in the oil refinery.

Continuous vacuum distillation is a well-developed process, and is to be found in almost every large modern refinery. The following examples illustrate its application:

1. The two-stage distillation unit, running to asphalt or heavy cylinder stock. It has become almost standard practice to recover all cuts boiling above gas oil under vacuum when a heavy residue is desired.

2. The vacuum flash tower. On certain crudes, reduction to a fuel oil bottoms in an atmospheric tower and vacuum

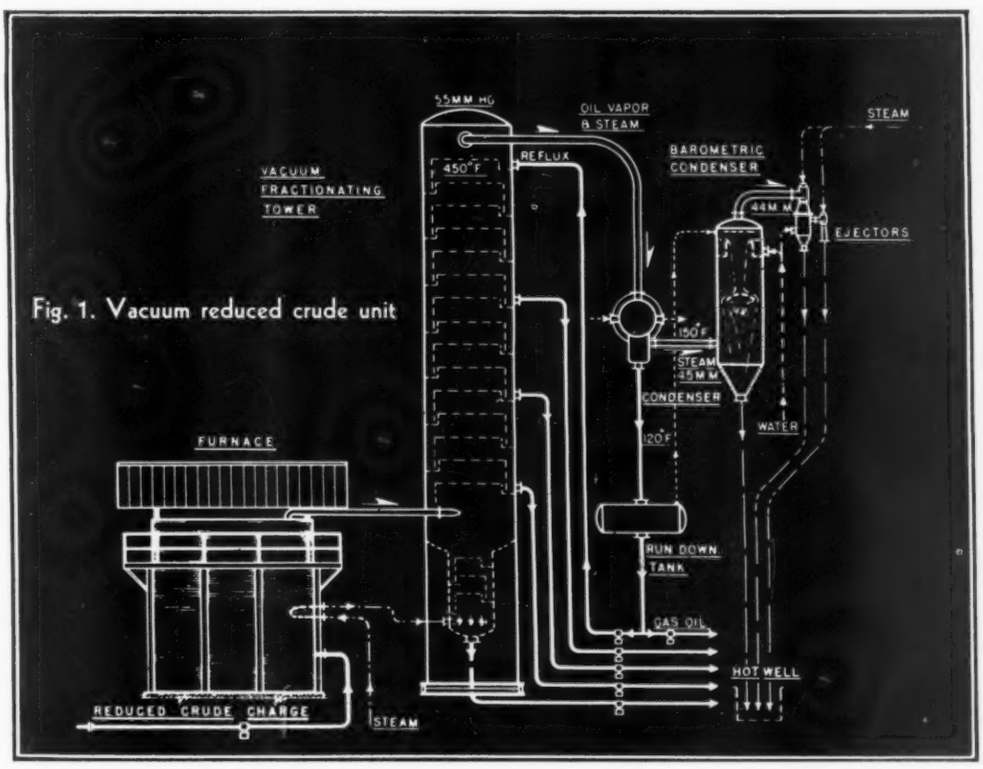


Fig. 1. Vacuum reduced crude unit

flashing of the residue to yield asphalt is desirable. Even vacuum towers have been provided with auxiliary flash towers for making an unusually low penetration asphalt residue on Mid-Continent Crude.

3. The vacuum flash tower for cracked residues. The use of vacuum flash towers for reducing cracking still tar to asphalt, and the recovery of gas oil that may in many instances be returned to the process, is increasing. In some cases the reduced crude charge is flashed, leaving a high quality virgin asphalt residue, the overhead being a clean charging stock. This practice will undoubtedly increase when old cracking processes are revamped.

4. The reduction of Pennsylvania cylinder stock to a highly viscous bottoms (800 SSU at 210 deg. fahr.), and the recovery of overhead lube stock.

5. The re-running of treated Pressure Distillate. This material must be distilled at such low temperatures, to prevent discoloration, that vacuum distillation of the heavy ends is usually necessary and economical.

6. The fractionation of solvent treated and de-asphaltized stocks. This will naturally require vacuum operation, and its development will increase. The operation will be highly similar to the vacuum distillation of reduced Coastal Crude.

In order to maintain a vacuum on any system, it is necessary to remove the vapors and gases continuously in the system by condensing the vapors, insofar as possible, and by removing the vapor-saturated gas by means of a suitable pump. Needless to say, the rate of vapor condensation and gas removal must correspond with the rate of vapor and gas production. Vacuum distillation is practical when:

a. The bulk of the distillate to be condensed and recovered has a low vapor pressure at circulating water temperature.

b. The non-condensable gases and vapors are present in such proportions that they can be pumped from the system economically.

It is most important for the designer of any distillation system to bear in mind that pumping vapors and gases to atmosphere from high vacuum is the most expensive pumping process known.

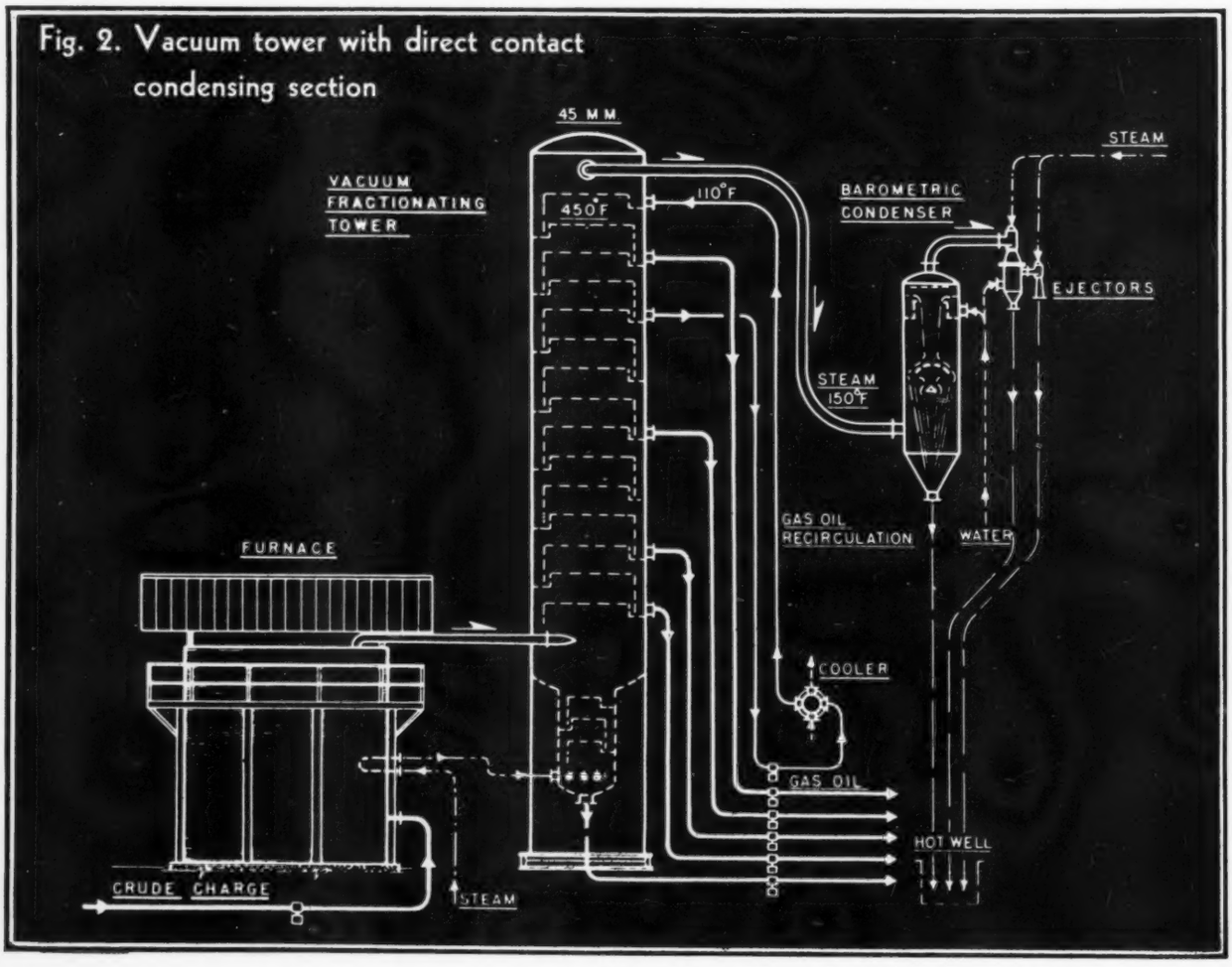
The conditions that occur in various problems of vacuum distillation vary, and may be illustrated by an examination of various oil refinery processes.

Fig. 1 illustrates a conventional vacuum distillation unit. The overhead distillate is mixed with steam, and has a considerably lower vapor pressure than water. It is then possible to condense the oil and the steam separately.

Here a conventional vacuum fractionating tower is shown. This set-up is typical for a two-stage crude unit, a reduced crude unit, or a lube re-run unit. The charge is usually a 50 percent reduced crude with an initial of 450-500 deg. fahrenheit. Gas oil is recovered overhead, while wax distillate, wax slop, and cylinder stock are drawn as side streams. In running naphthenic crudes or dewaxed lube stock, several neutral cuts are taken.

From 12 to 20 trays above the tower inlet and four below the inlet are used. The pressure drop is 50-70 mm. from the

Fig. 2. Vacuum tower with direct contact condensing section



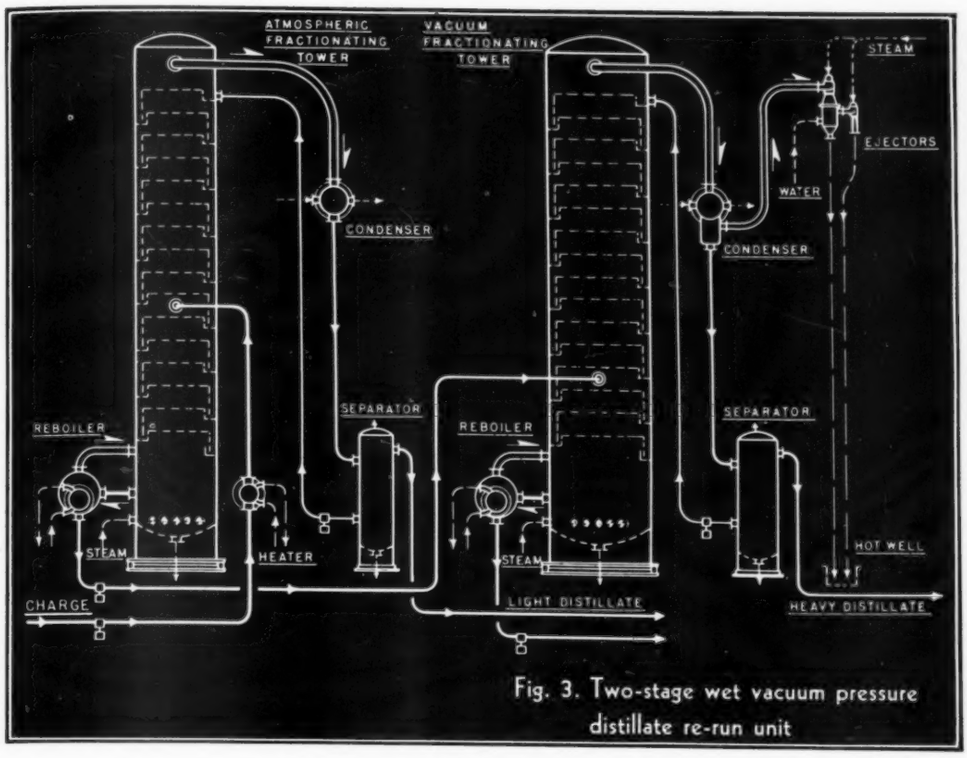


Fig. 3. Two-stage wet vacuum pressure distillate re-run unit

flash zone of the tower to the air ejector inlet. About 40-50 mm. absolute pressure is maintained at this point, giving an absolute pressure of 90-120 mm. at the flash zone. Steam is introduced in the bottom to produce a low partial pressure of the oil vapors. The unvaporized feed flashes in the lower stripping trays, thereby losing sensible heat.

In this case the overhead distillate is usually a gas oil, with the initial boiling point above 400 deg fahr., and preferably above 500 deg. fahrenheit. Due to the low vapor pressure of the gas oil leaving the surface condenser, an insignificant quantity is carried to the barometric steam condenser.

With this design, the absolute pressure on the system is determined by the vapor pressure of steam condensing in the barometric condenser.

A variation on this scheme is shown in Fig. 2. Here the surface condenser is replaced by a direct contact condenser for the oil vapors. Gas oil is recirculated through coolers and over trays or other means of obtaining contact with the rising vapors. This scheme eliminates oil vapor lines, structural steel supports, and conditions of temperature stress that make surface condensers unsuitable. On the other hand, a rather large circulating pump is required, and the temperature head on the coolers is reduced, often resulting in a larger surface than required for condensers alone. It is sometimes claimed that this device will give a lower pressure drop than a surface oil condenser. This is not necessarily true, particularly when trays are used to obtain contact between the vapor and liquid. An ordinary fractionating tray will give two to three mm. Hg pressure drop. Four trays, therefore, are on a par with the usual pressure drops encountered in surface condensers.

On small flash towers, this method is particularly applicable and economical, since vapor temperatures range from 600 deg. fahr. to 750 deg. fahr., making the mechanical design of

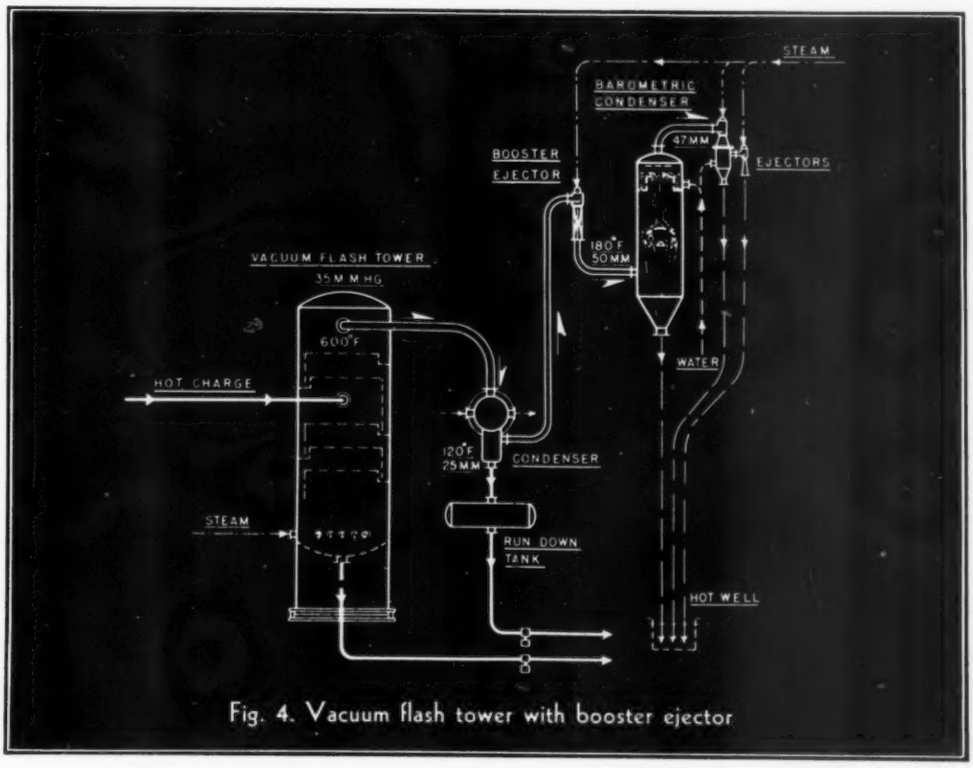
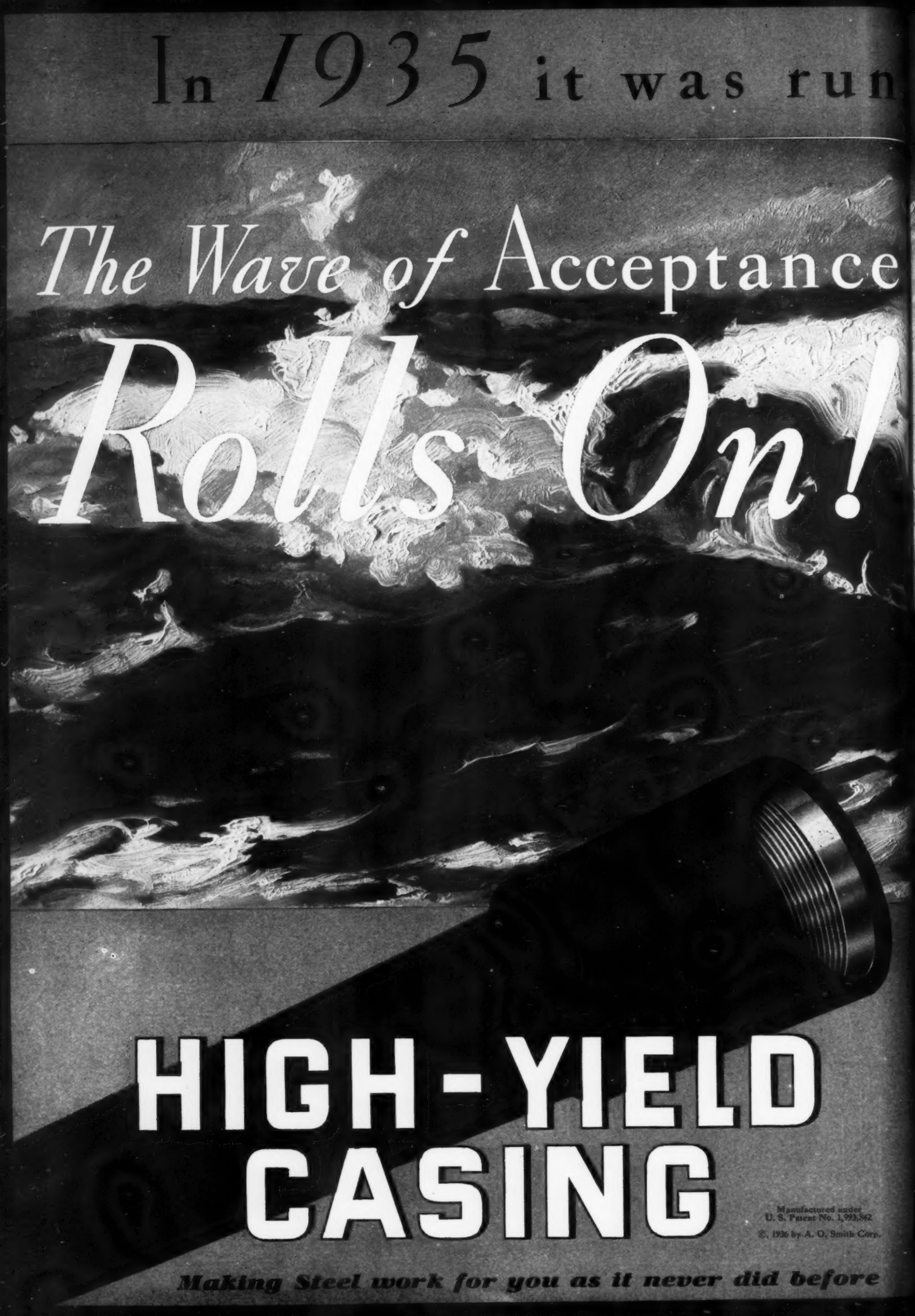


Fig. 4. Vacuum flash tower with booster ejector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the surface condenser a difficult matter.

When the distillate recovered has an initial boiling point of 300 deg. fahr. or less, it is in the boiling range of water, and the steam and distillate must be condensed together. Since the distillate and water condensate must be separated, surface condensers are required for this condition. This arrangement is shown in Fig. 3. The inevitable air pump takes suction from the surface condenser hotwell.

This condition is usual in the two-stage pressure distillate re-run unit. The heavy portion of the distillate must be recovered under vacuum because of a usual maximum limiting distillation temperature of 275 deg. fahrenheit. The bottoms from the first stage are pumped to the second stage, which is a vacuum tower having 12 to 14 trays. No side cuts are made.

In designing a pressure distillate re-run unit, we must strike a proper economic balance between the surface condenser size, the ejector size, steam and water consumption, and loss of distillate with the N.C. gas, keeping the following controlling factors in mind:

1. Vapor pressure of oil condensate
2. Vapor pressure of water condensate
3. Quantity of non-condensable gas
4. Circulating water temperature.

The combined carrying effect of N.C. gas and its ever present associate, water vapor, is increased by an increase of hotwell temperature and a decrease of absolute pressure at the inlet to the air pump. The loss of distillate from the system is large, and consequently absolute pressures below 75 mm. at the top of the fractionating column are difficult to obtain. With surface inter- and after-condensers on the ejectors, the overhead distillate loss is recovered. The question of oil carry-over then becomes solely a question of ejector size.

It may be noted that the presence of water and oil of the same vapor pressure together increases the saturation of the gases the vacuum pump must handle. It follows that the elimination of steam will result in a much lower obtainable absolute pressure and that oftentimes, because of the loss of low-boiling distillates caused by the use of steam, or because of the actually better distillation conditions obtained without its use, dry vacuum distillation becomes advisable. The dry distillation system may be set up in accordance with Fig. 3 or Fig. 2, the barometric condenser being eliminated. Many pressure distillate re-run units are therefore designed for dry vacuum operation.

Although the writer has never seen any definitely substantiating data, it is held by some that steam has a slight tendency to oxidize oil under maximum distillation temperature conditions. Partly for the fear of some deleterious effect of stripping steam, and for reasons of personal preference, patents, and general policy, dry vacuum distillation, even on heavy oils, is often used.

In Fig. 4 is shown a vacuum tower with a booster ejector. Oil is condensed in a surface condenser in which the total pressure is less than that obtainable by a barometric condenser. Steam is pumped by a large steam jet ejector to a barometric condenser. In an ordinary vacuum fractionating tower making several cuts, the maintenance of an unusually low absolute pressure at the top by this means is not justifiable. Twenty bubble trays produce 40-50 mm. Hg pressure drop. Hence the maintenance by expensive means of 20 mm. at the top of the tower instead of 45 mm. is not advisable when the result is 70 mm. at the flash point instead of 85 or 90 mm. Additional steaming with exhaust steam in any quantity required is usually to be preferred to the live steam needed to produce a very low absolute pressure by pumping the steam to a barometric condenser. In a tower with no trays or only a few trays, the process looks more attractive.

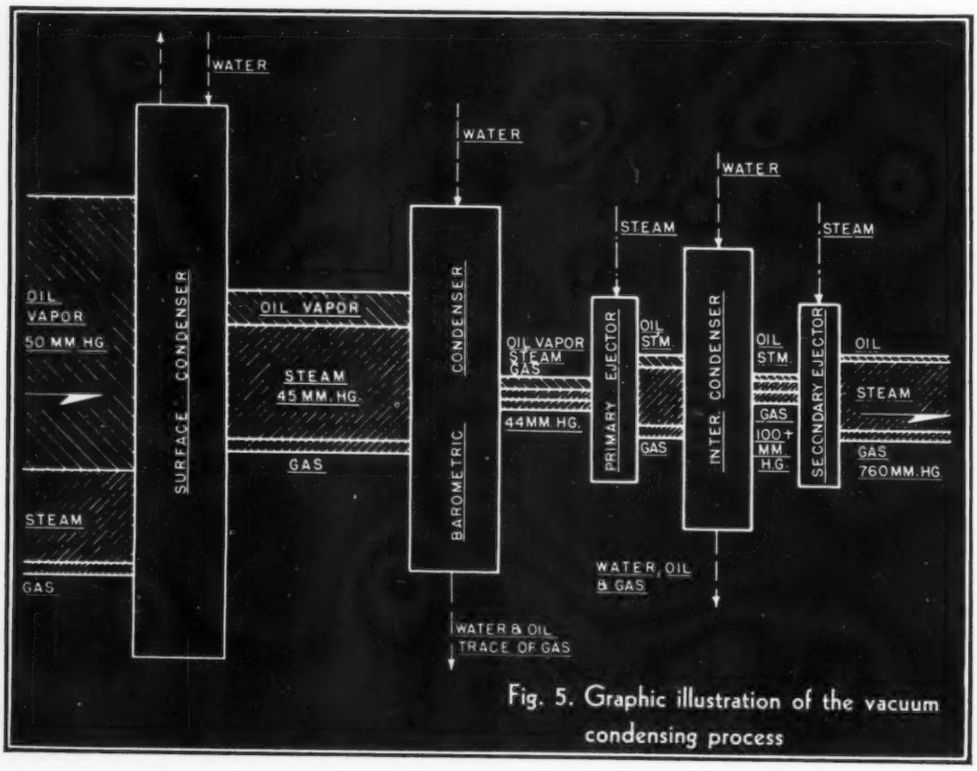

Fig. 5. Graphic illustration of the vacuum condensing process

The absolute pressure of the surface condenser hotwell is equal to the sum of the vapor pressure of the oil and the partial pressure of the steam. It is practically limited, therefore, by the permissible carry-over to the booster. The amount of booster steam required depends on the amount of process steam to be handled, the compression ratio, and the pressure of the live steam. An economic balance of these inter-dependent influences must be found. Naturally, the

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less the pressure drop to the flash zone, the more favorable the use of the booster ejector becomes. At one time it was widely advocated for use with a fractional condenser. It is at present considered for use when flashing a virgin asphalt flux, or a cylinder stock, where fractionation is not required and a high boiling material is to be handled. In general, one to two lb. of live steam per lb. of process steam are required for the booster.

The requirements for maintaining a vacuum, *i.e.*, continuous condensation of vapors and removal of air, is illustrated in Fig. 5. A successive condensation, accompanied by pressure drop, occurs toward the ejector inlet. At this point, the lowest absolute pressure in the system exists. From this point on, the absolute pressure is raised to atmospheric at the expense of live steam. The inter-condenser condenses the exhaust, and much of the primary ejector load. The primary ejector controls the vacuum. Its capacity is the neck of the bottle. The circulating water temperature and the vapor pressure of the oil only influence the vacuum insofar as they influence the ejector load and the pressure drop up to the ejector inlet. With a large enough ejector, no condensers would be needed to maintain a vacuum. The booster ejector scheme approaches this idea. Condensers are used to reduce the size of the air pump to a minimum, and to recover the products easily.

A steam jet air ejector element is shown diagramatically in Fig. 6. It consists essentially of a steam nozzle, air chamber, and diffuser piece. Steam expands through the nozzle, issuing at a high velocity. This entrains the gases admitted to the diffuser throat, and imparts velocity to them by impact. This kinetic energy is transferred into pressure by the diffuser, which increases in area and reduces the velocity.

The fundamental principle of the design of ejectors is the proper location and arrangement of the nozzle so as to get an effective impact of the steam with the gas to be pumped. The use of multiple nozzles to give a high contact surface of steam and air is often practiced. The length of the diffuser, its shape, and the position of the nozzle with respect to the throat are very important. Manufacturers of ejectors are forced to use expensive trial-and-error methods to acquire this knowledge, and very little information is published. In purchasing ejectors, surprising differences of guaranteed steam consumption may sometimes be noticed, because, no doubt, of the generally undeveloped state of the art except among a few manufacturers.

A steam nozzle operates best over a definite pressure drop. A change of initial pressure causes diffusion of the issuing jet of steam, resulting in eddies and a loss of energy. In a steam jet ejector, this effect is pronounced because of the resulting inefficient impact and entrainment of the gas to be compressed. Consequently a change in pressure of the steam, particularly by a drop in pressure, greatly upsets the operation of an ejector. A drop of ten percent below designed initial pressure will usually cause an ejector to stop functioning altogether and the vacuum is lost, sometimes under conditions that are apt to be dangerous, as when air is drawn back into a tower containing hot inflammable vapors.

It is necessary, then, to insure a steady boiler pressure, and to select the ejector to operate on steam at a pressure 20 lb. to 30 lb. below boiler pressure. A reducing valve can then be used to maintain steady steam on the ejectors, even though the boiler pressure may fluctuate.

It may be noted, then, that an ejector cannot be throttled. A characteristic of all nozzles having a drop below the critical pressure is that the weight flow depends only on the upstream pressure. Hence the steam consumption of an ejector depends on the absolute pressure of the live steam. If an ejector designed for steam at 85 lb. is supplied with steam at 95 lb., the steam consumption is $(95 + 15) \div (85 + 15) = 1.10$ times the guaranteed quantity. This additional steam will, however, carry little additional load because of the lower nozzle and throat efficiency. Any attempt to reduce the steam consumption by throttling will result in a loss of vacuum. It is therefore advisable to install two or three batteries of ejectors so that one may be shut off under light load conditions.

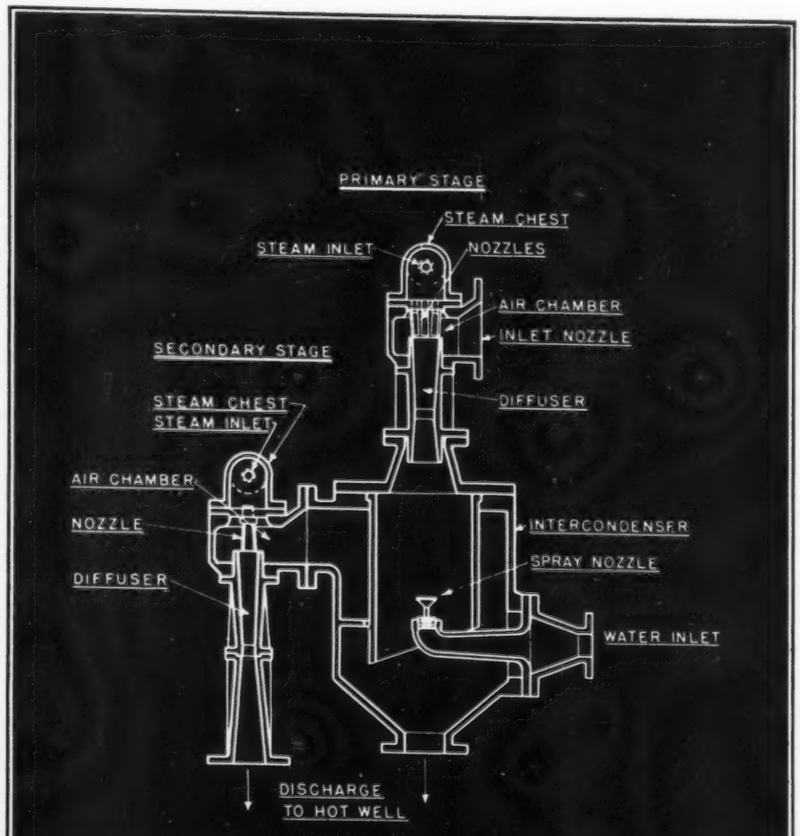
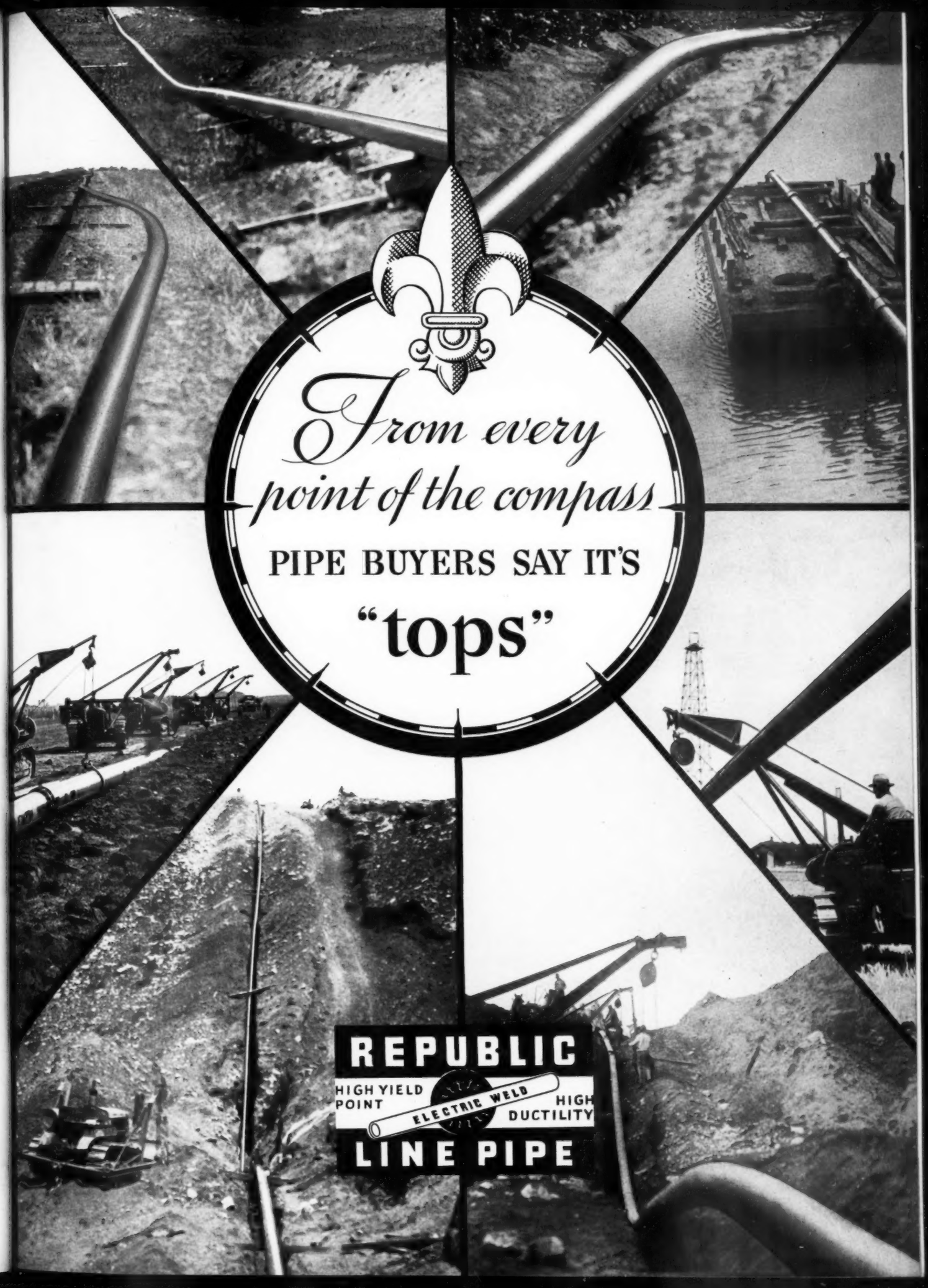


Fig. 6. Two-stage ejector with jet intercondenser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Part VII

Controlled Directional Well-Drilling and Surveying Practice

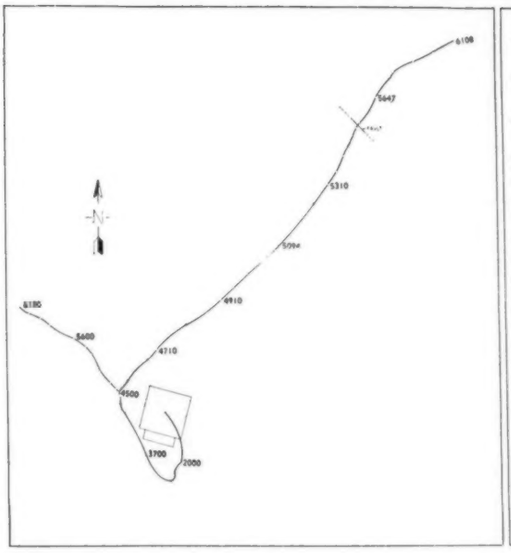


Fig. 41 Fig. 41-A

IN Figs. 41 and 41A are shown the plats of a job where the operator desired to deflect across a fault, an operation that was successfully accomplished. As a matter of fact, crossing faults comprises approximately ten percent of the total deflecting work in the Gulf Coast. The speed of progress in this type job depends a great deal upon the horizontal angle at which the directed hole attacks the fault plane. If very acute, a pronounced tendency to slide along the plane is encountered. When such a condition is present the result of a whipstock setting is very often neutralized by this stratigraphical tendency. In a number of such instances, when the hole was sliding to the right, the disc bit shown in Fig. 31 has succeeded in penetrating the fault plane. Usually there is sufficient geological control to establish the strike more or less accurately, in which case it is simple enough to control the hole in order that it may meet the fault plane at right angles, an approach that has been found to present no trouble.

Fig. 42 illustrates the application of directional drilling to overhanging salt dome structures and is self-explanatory.

Figs. 43 and 43A illustrate a combination of cases 3 and 5, where a Gulf Coast operator desired to work over a well that had reached the marginal stage by deflecting it farther up structure under the overhang.

In this instance the original well was surveyed to bottom, from which was calculated the most advantageous point at which to mill out of the 7-in. casing. A casing whipstock was then oriented to this point and landed in the desired direction, upon tripping and setting, from some reason not apparent at the surface, the whipstock turned slightly to the left. This entailed but little additional trouble, the hole was gently turned to the right and bottomed-up almost under the derrick. The fact that the original well was drilled before much thought was being given to vertical holes, and that its old bottom was some 447 ft. down dome, illustrates better than words the necessity for single-shot surveying a hole during drilling progress. The new deflected hole came in for several hundred barrels, due to its new position in comparatively little-drained territory, the existence of which was unsuspected until the survey was made.

Figs. 44 and 44A illustrate case 4, in which a company had the lease under a bayou 200 ft. wide. The well was started on shore and drilling controlled so that at 8000 ft. the bottom of the hole was well within bounds. The unique feature of this particular job was that not one deflecting tool was used throughout the work.

This application is not limited to water jobs but is equally adaptable to town-lot drilling where a proper location might fall upon the site of a valuable building, or a restricted area where opposition to a drilling site is often encountered. The

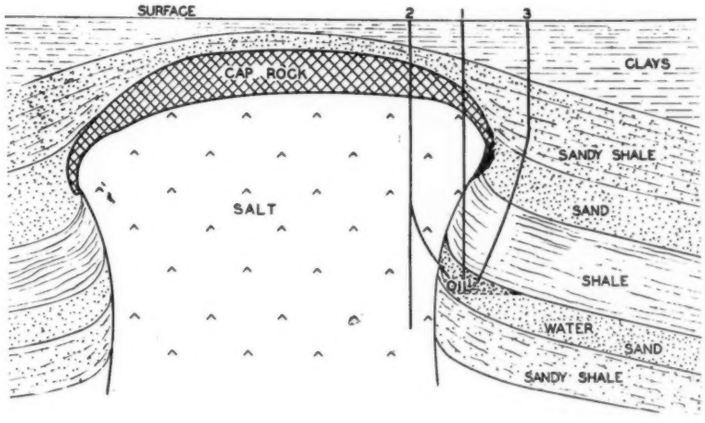


Fig. 42. Overhanging salt domes. 1. Typical well drilled through overhang. 2. Well missed the overhang — plugged back and deflected into oil sand. 3. Well purposely drilled to miss overhang and deflected into oil sand.

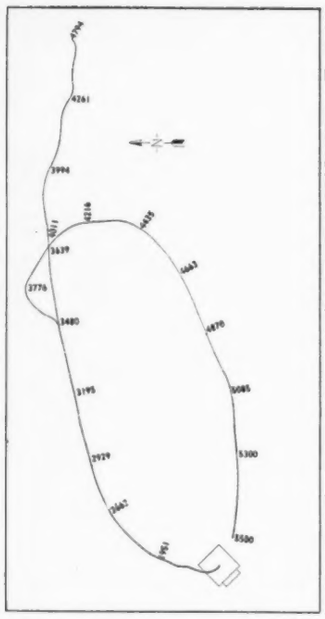


Fig. 43

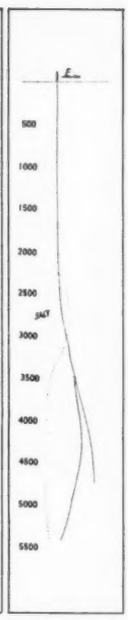


Fig. 43-A

legalized activities of the writer's organization under graveyards, if not notorious, have at least contributed to oilfield history. It is possible that the problem of recovering the oil under the Capitol site of Oklahoma may be neatly and orderly solved by this application of controlled directional drilling.[22]

Fig. 45

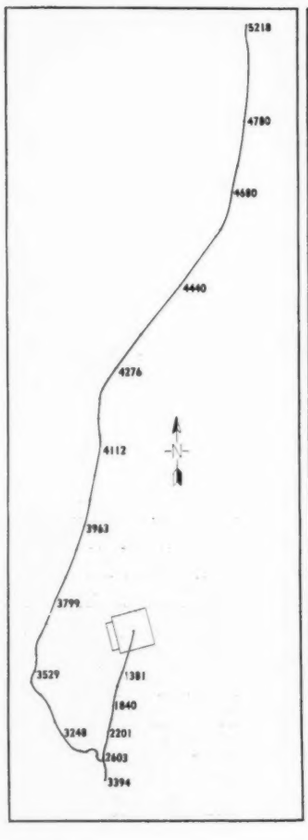
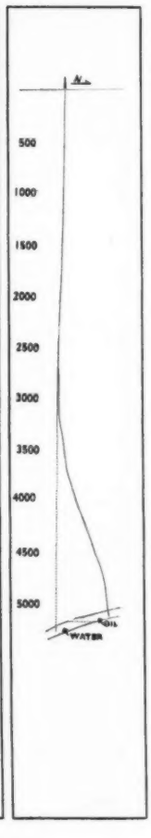


Fig. 45-A



Figs. 45 and 45A illustrate case 5. In this instance a 5000-ft. well was drilled into salt water. The well was surveyed and found to have drifted slightly down structure. It was plugged back to 2600 ft. and directed up structure some 490 ft. from that point. The new hole was brought in for a good well, and saved an investment that otherwise would have been a total loss. Similar jobs have been done to kick a well out of an area of high gas-oil ratio into a lower one.

In drilling sulphur wells and the preliminary boundary wells in which mud is pumped into the fissures and fractures to seal off the prospective producing area, it is imperative that the hole penetrate these porous breaks. Cores frequently show that the hole is in a tight and unbroken spot; it is then that the hole may be deviated sometimes only a few feet to pick up the fissures again.

Case 6, in which relief holes are drilled to kill wild burning or cratered wells, is undoubtedly the most spectacular application of directional drilling. Three such wells have been drilled in as many years, both here and abroad.[23, 24, 25]

Because of the necessary precision and economy of time every consideration is given the project before work is started. In fact the entire hole and every move is planned in advance, and for this reason the actual mechanics of the control work is more simple than on other jobs.

Before making the relief location the local strike and dip of the beds are studied as well as the lithology. The direction of prevailing winds is determined. The origin of the escaping oil and/or gas is determined as closely as possible. The dr.lling log is studied and all surveys noted. These and other minor considerations enter into the location.

In rigging up, a great deal of attention is given to time-saving methods and appliances. Unless a high drift angle is required, the surface casing is landed in a vertical hole. Below this point, the hole is carried vertical until the depth is reached where it has been planned to begin deflection.

If no directional survey of the wild well is available, the straight-hole information derived from some form of drift indicator is platted, assuming that the deviation was cumulative in some one direction, and again assuming

[22] "Deflected Drilling Would Enable State to Get Oil Under Capitol," by L. G. E. Bignell, *Oil and Gas Journal*, January 9, 1936.
[23] "Several Methods Used in Fight to Control Gas Craters Developed Around Roumanian Well," by Eugene Guman, *Oil Weekly*, September 16, 1935.
[24] "Conroe Wild Crater Well Under Control," by Brad Mills, *Oil Weekly*, January 15, 1934.
[25] "Directional Well is Successfully Employed to Subdue Stubborn Fire," by Neil Williams, *Oil and Gas Journal*, January 10, 1935.

Fig. 44

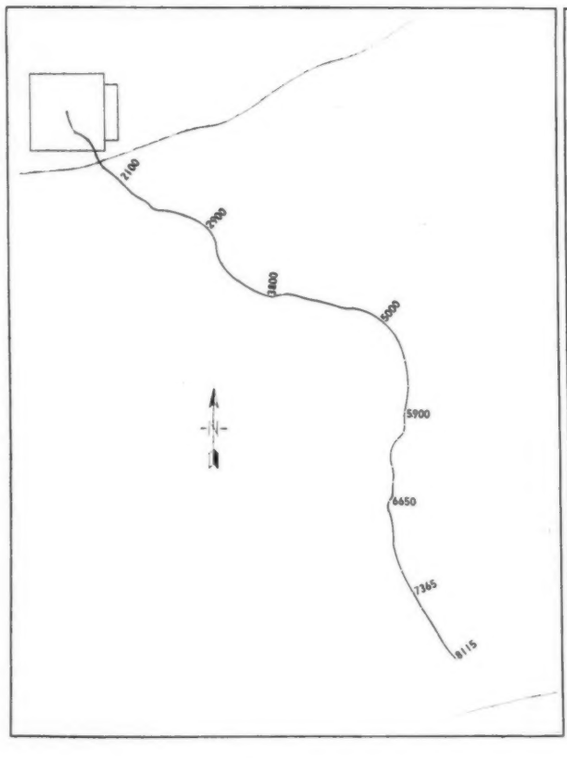
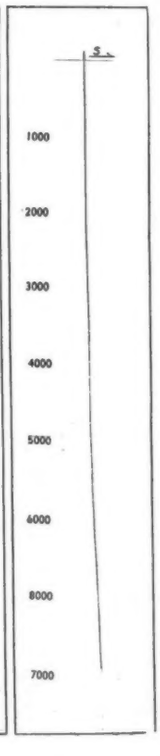
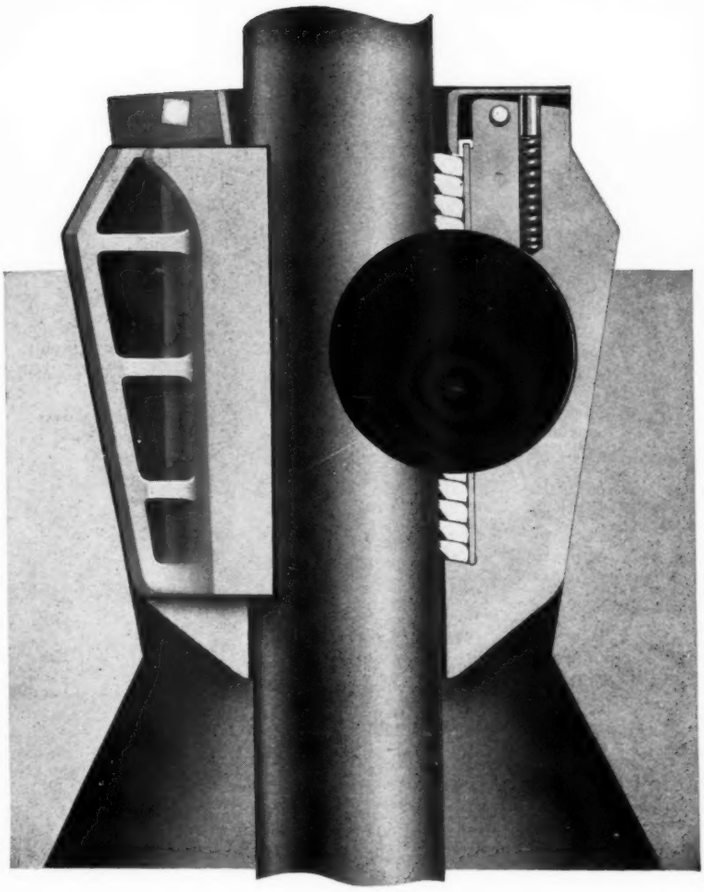


Fig. 44-A





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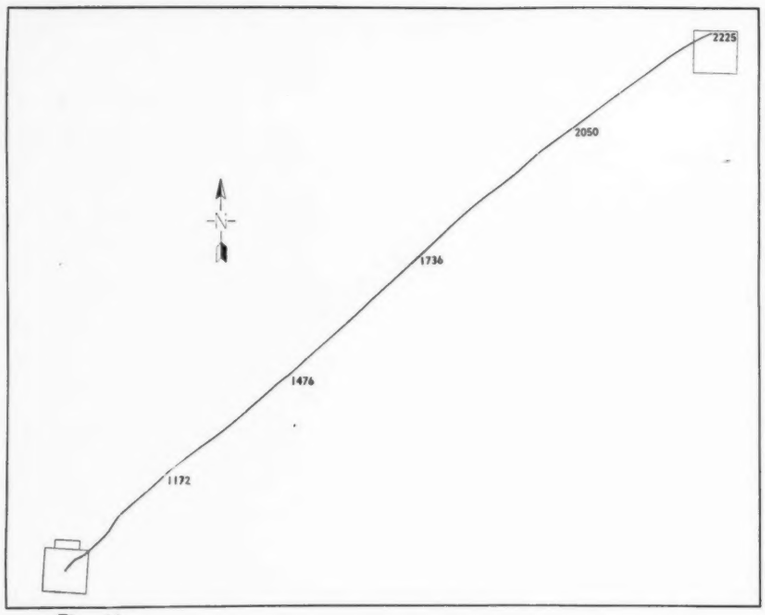

Fig. 46

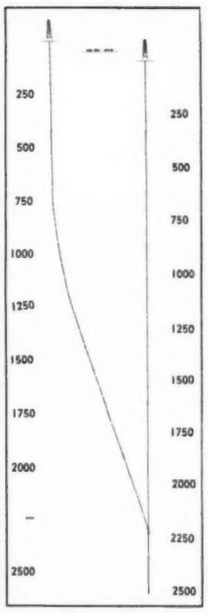

Fig. 46-A

it compensating in the same directional plane. Knowing from experience the influence of structure upon deviation, the most probable direction of deviation is laid off from the cratered well. Upon it is laid off the maximum and minimum deviation as computed from the drift indicator information. Keeping in mind the crawling tendencies of the type bit to be used, and the influences of structure upon its travel, a course is laid off for the relief hole. A vertical course or grade is also computed and platted.

With all in readiness when the relief hole reaches the point at which deflection is to be started, a whipstock is set to drill off on the established course. One whipstock setting follows another until the desired drift angle is built up to correspond with the previously computed grade.

When the drift angle and direction are satisfactory, the limber set-up used on bottom is replaced by large stiff drill collars and joints of large diameter drill pipe, sometimes stabilizing reamers (smooth surface rollers) and lace joints are also used. This stiffening of the bottom section serves to hold the relief hole on its course with a minimum of crawl. Single-shot surveys are made at 100-ft. intervals and the actual position platted upon the course and grade sheets. Slight deviations are corrected by bit control, larger deviations by whipstock setting.

Any consistent deviation is studied with reference to structure and a correction applied to the estimated objective. In this manner, by inference and deduction, the location of the objective is defined fairly well, and accurately enough.

At the first good seat close to the objective sand, casing is landed, cemented, and blow-out equipment is installed. At the same time provision is made for pumping fluid into the hole below the preventer. During this time, reserve pits of mud are mixed and agitated.

When all is in readiness, the plug is drilled out and the relief hole continued. Upon reaching the objective sand, the blow-out preventers are closed and the pumps tied in to the large mud pits. Pressure is built up until the fluid "breaks through" or circulation is established between the two holes. Rate of circulation is then automatically increased. Behind the thin mud, heavier weighted mud is circulated until the wild well is completely dead, then cement slurry can be pumped in and the whole matter forgotten.

Figs. 46 and 46A illustrate the job done on the cratered Sonda No. 5, Transylvania, Roumania.

The remarkable consistency with which the bulls-eye is hit in this most advanced application of directional drilling, demonstrates most strikingly the accuracy of both the surveys and the whipstock settings.

In Fig. 47 is shown how a number of deflected holes from the original can serve the petroleum geologist as it has in the past served mining engineers in subsurface exploration.

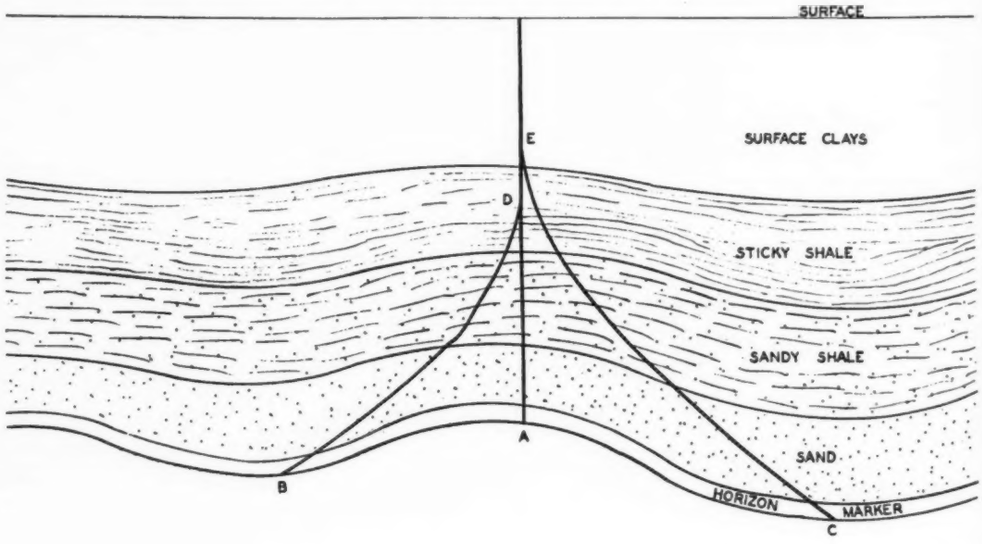

Fig. 47. Geological exploration. Straight hole drilled to A. Hole plugged back to D and a controlled deflected hole drilled to B. Hole plugged back to E and a controlled deflected hole drilled to C.

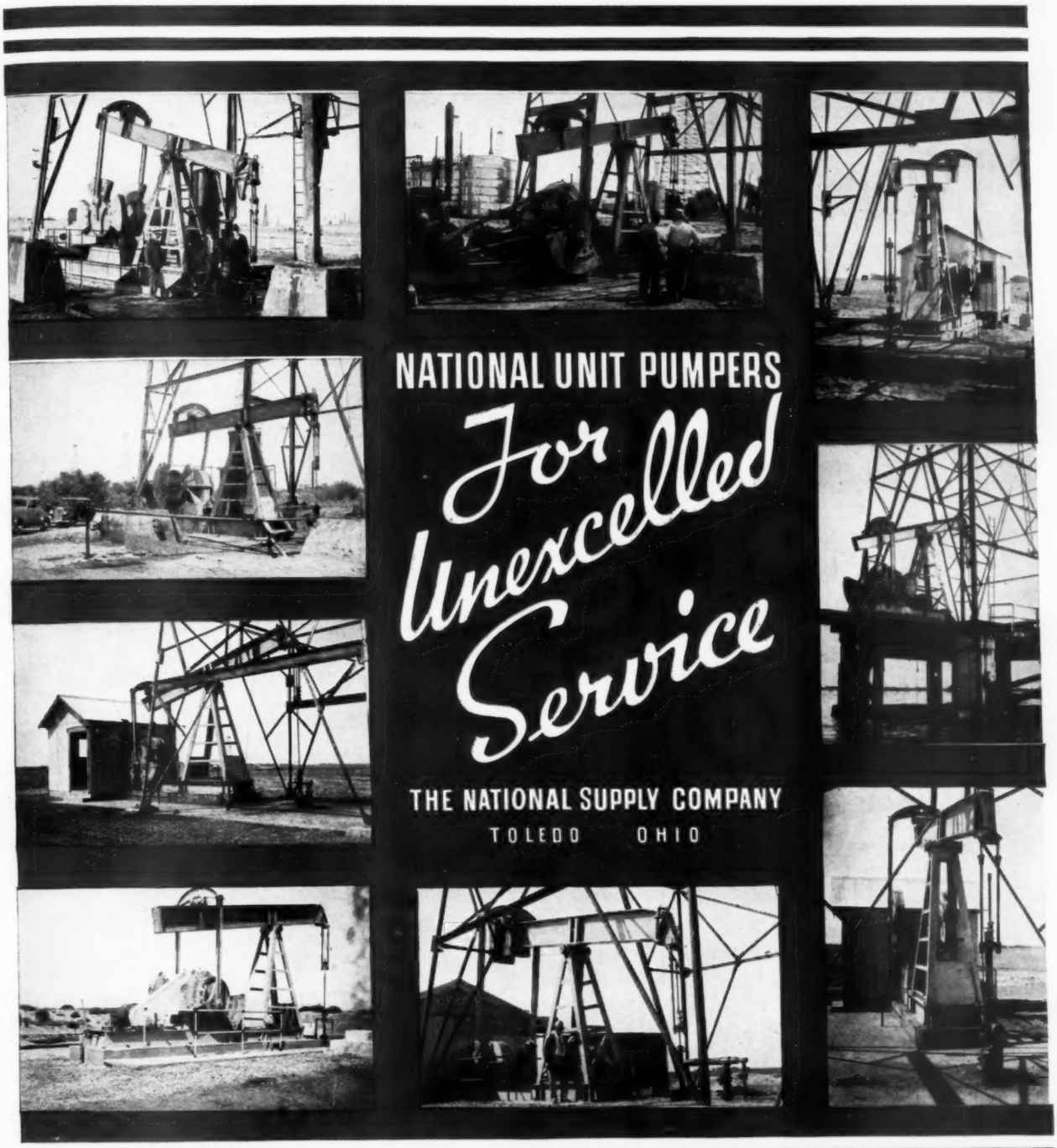
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Fig. 48 illustrates the manner in which the limits of a salt dome may be positively located at a cost far under the stereotyped system of drilling a number of wells along an axis.

Practical exploitation of the theory of drilling more than one well from the same location has been practiced upon the Pacific Coast.[26] A similar though modified system is soon to be put into practice in the Gulf Coast, where an operator whose leases are all submerged, plans to build one derrick location of unusual base dimensions, and drill four deflected holes to properly-spaced positions on the sand by shifting the drawworks and rotary, each hole to be independent of the others.

From the foregoing series of articles outlining the principles and practices of oil well surveying and directional drilling the reader can possibly sense the great strides that have been made in perfecting and refining the art.

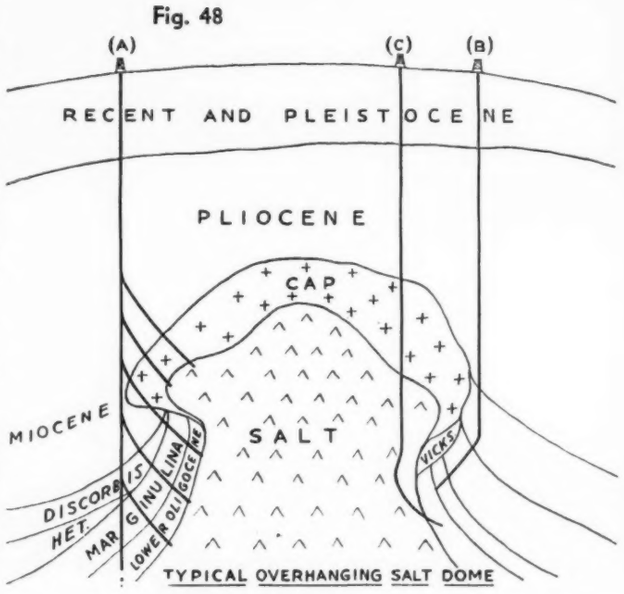
Improvement and development are the order of the day. New tools even now are under fabrication that will speed up enormously directional operations and bring a new and salutary economy.

This technical enterprise has won its place in the industry and will become more widely and universally employed as it becomes more generally understood and its benefits appreciated.

In conclusion the writer invites any criticism and discussion upon the subject from the readers, to the end that a better understanding obtain through exchange of ideas and information.

(EDITOR'S NOTE: This concludes this series of articles).

Fig. 48



[26] "Multiple Drilling Successfully Permits Three Wells Under One Location," by Brad Mills, *Oil Weekly*, April 29, 1935.

Annual Meeting Mid-Continent District A.P.I. in Wichita, Kansas

THE tenth annual meeting of the Mid-Continent District, Production Division, American Petroleum Institute, will be held in Wichita, Kansas, February 20 and 21, the Kansas Chapter acting as host. Convention headquarters will be at the Allis Hotel. The program follows:

THURSDAY, FEBRUARY 20, 1936

8:30 a. m.—10:00 a. m.

Registration, Mezzanine Floor

Address of Welcome:
Ralph J. Pryor, vice-president, Slick, Pryor and Lockhart, Inc.

Morning

Presiding: C. A. Daniels, Phillips Petroleum Company.

10:00—"Individual Pumping Unit and Its Engine Power"
J. S. Montgomery, Phillips Petroleum Company.
"Gas Repressuring in Eastern Kansas"
N. M. Hutchinson, Empire Oil and Refining Company.

Afternoon

Presiding: Max Mahaffey, Empire Oil and Refining Company.

2:00—"Disposal of Production Wastes"
(1) "Conservation of Fresh Water"
R. C. Mitchell, State Board of Health.
(2) "Underground Disposal of Salt Water"
Marvin Lee, technical advisor, State Corporation Commission.
"Potential Petroleum Reserves in Western and Eastern Colorado"
L. C. Morgan, consulting geologist
Boris V. Lerke, consulting micro-paleontologist.

6:00—Dinner and entertainment
Allsteel Products Manufacturing Company, 801 South Wichita Street, Wichita, Kansas.

FRIDAY, FEBRUARY 21, 1936

Morning

Presiding: A. S. Ritchie, McPherson Drilling Company.

9:30—"Dynamometer Tests Indicate Present Pumping Methods Subject Sucker Rods to Unnecessary Loads"
Presented by H. D. Collins, Gypsy Oil Company.
Author: J. F. Eaton, Jarecki Manufacturing Company.
"Prime Movers for Drilling in the Mid-Continent"
J. A. Niles, Stanolind Oil and Gas Company
W. C. Dreyer, Westinghouse Electric and Manufacturing Company.

Afternoon

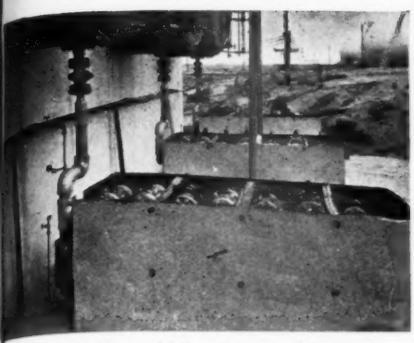
Presiding: C. O. Rison, I.T.I.O. Co.

2:00—"General Principles Underlying Electrical Logging and Its Applications"
L. W. Storm, Schlumberger Well Surveying Corporation.
"Present Production Methods—Oklahoma City Field"
F. A. Lichtenheld, I.T.I.O. Co.

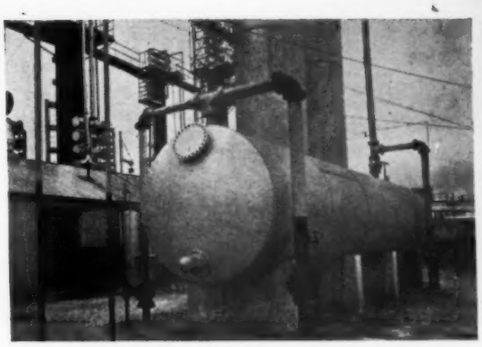
6:30—Banquet and entertainment
Ballroom, Allis Hotel, Wichita, Kansas.

Mid-Continent District officers for 1935: Chairman, C. A. Daniels, Phillips Petroleum Company; vice-chairman, T. J. Hamilton, Phillips Petroleum Company; vice-chairman, M. W. Birmingham, Indian Territory Illuminating Oil Company; and secretary-treasurer, G. A. Holloway, Lee C. Moore and Company, Inc.

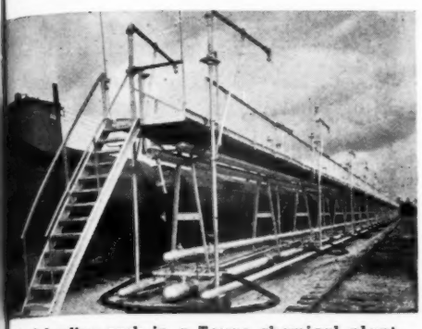
Chairmen of the convention committees are: Program, G. A. Holloway, Lee C. Moore and Company, Inc.; publicity, H. W. Cardwell, Allsteel Products Manufacturing Company; entertainment, Ed Swearer, independent operator; registration, Harry Glover, Derby Oil Company; transportation, George Hoisington, Halliburton Oil Well Cementing Company; and special committee on papers and discussion, Van D. Bennett, Derby Oil Company.



Manifold headers on high-pressure tanks, showing Nordstrom Lubricated Valves packed in cottonseed for protection against low temperatures.



Horizontal settling tank in a Borger, Texas, refinery. Equipped with 4" and 6" Nordstrom Valves for 150 and 250-lb. pressures.

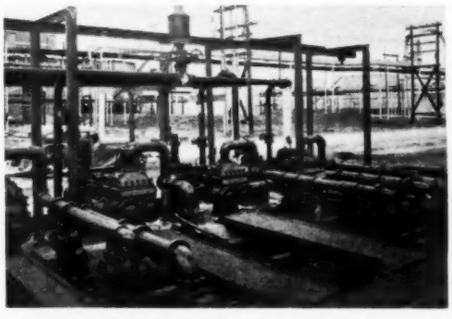


Steel loading rack in a Texas chemical plant, equipped with 2" and 3" Nordstrom Valves.

Repressuring plant at Sugarland, Texas. Horizontal units are gas coolers, reducing temperature from 280° to 80°. Equipped with Nordstrom Valves; also 4" Nordstrom Hypreseals.

Nordstrom Valves on Scrubbers. Range of pressure from 4-inch vacuum to 4-lb. Inlet lines to left. Gas outlet lines at top from Scrubbers to gas compressors.

Superheater water lines. All valves are Nordstroms —12" on main lines, gear-operated, 6" valves on manifold and 4" Nordstroms on steam lines.

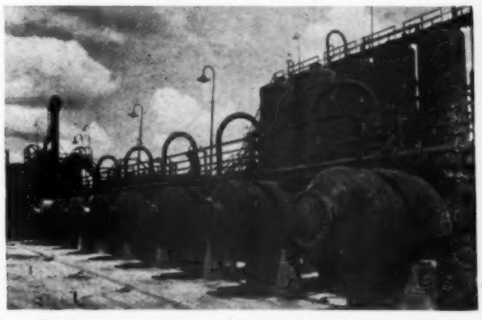


Naphtha manifold transfer pumps in a Texas refinery. Equipped with 150-lb. Nordstrom Valves on 6" discharge and 10" suction lines.

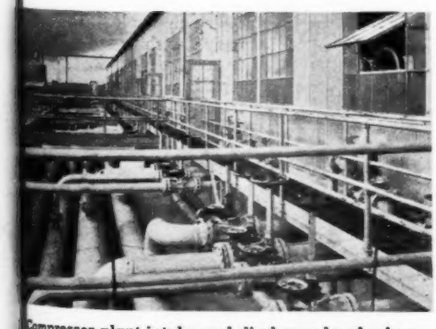
Manifold in a Texas gasoline plant. 10" and 8" Nordstrom Valves on suction lines. 4" and 6" Nordstroms on discharge lines.

Twenty-two discharge lines equipped with 2" Nordstroms carrying 600 lbs. pressure, frequently increasing to 1000 lbs. The two Nordstroms in foreground are on relief lines.

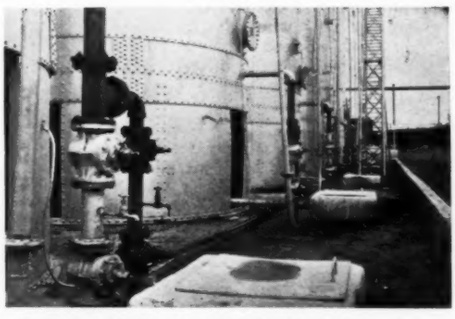
View of ten compressors; six low-stage and four high-stage. The high-stage compressors carry 400-lb. and 1400-lb. pressure on discharge. All lines have Nordstrom valves in 2", 4" and 6", replacing gate valves.



Battery of eight continuous naphtha treaters with 4" lines, all equipped with Nordstrom Lubricated Valves.



Compressor plant intake and discharge header in a Texas field, equipped with thirty-two 6" Nordstroms and thirty-two 8" Nordstroms carrying 500-lb. pressure.



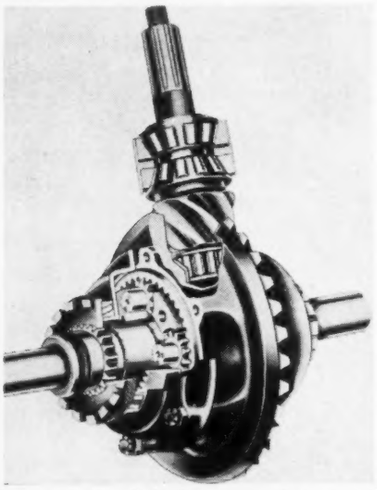
Agitator tanks in a treating plant in the Texas Panhandle. Nordstrom 4" 150-lb. Valves are shown.

Advertisement

Ship loading pump house handling gasoline. 10" discharge line and 12" suction lines. 16" line to loading dock. All valves are Nordstroms.

International Announces Two-Speed Axle Models

INTERNATIONAL Harvester Company has announced the addition of three new models to its line of motor trucks, each of which features two-speed axle construction providing eight forward and two reverse speeds. With this construction all the advantages offered by both the high-speed and low-speed axle ratios are combined in one unit. The new models are the CS-30, CS-35, and CS-35-T.



Cutaway view of the International two-speed rear axle. This shows the four planetary gears in the unlocked or low-speed position. The truck can now operate through any transmission gear as a powerful low-speed unit.

In the past it has been necessary for truck owners requiring variable performance ability to choose between a high- or low-speed axle ratio. The high-speed axle ratio would allow the truck to be driven on level roads at high speeds with consequent saving in engine wear, and gasoline and oil consumption, due to slower engine speeds. The objection to the high-speed axle ratio was that payload must be sacrificed if hills and rough roads were to be negotiated. If operating conditions necessitated using a low-speed axle ratio, engine wear and gas and oil consumption were increased due to higher engine speeds. Road speeds with the low-speed axle ratio naturally were sacrificed for the necessary power.

With the International two-speed rear axle models, however, the truck owner has both speed and power, combined and available in one unit. The low-gear axle ratio enables heavy loads to be hauled up steep hills and over rough roads, while the high-gear axle ratio allows high speeds on level roads or with light loads. A simple movement of the shifting lever and the driver changes to either low-speed or high-speed operation instantly and silently without stopping the truck. This two-speed rear axle is available in both the 5.14 to 1-7.15 to 1 and the 6.16 to 1-8.57 to 1 axle ratios.

The Model CS-30 is available in two wheelbases—133 and 157 in., while the Model CS-35 is offered in 136-, 160-, and 175-in. wheelbases. The six-wheeler Model CS-35-T is built in two wheelbases—168 and 180 inches.

All models are powered by six-cylinder engines of International Harvester design and manufacture. The Model CS-30 engine is of the L-head type with dome-type combustion chambers. At 3400 r.p.m. this engine develops 78.5 b.hp. with a maximum torque of 151 lb-ft. at 800 to 1400 r.p.m. Bore and stroke are 3 5/16 and 4⅛ in., respectively. The clutch is of the single-plate type with built-in vibration damper, and the transmission has four speeds forward and one reverse, giving a total of eight forward and two reverse speeds when employing the two ranges of the rear axle.

The Model CS-35 power plant is of the valve-in-head type with replaceable cylinders. Bore and stroke are 3 7/16 and 4 in. respectively. This heavy-duty truck power plant develops 160 lb-ft. torque at 800 to 1500 r.p.m. and a maximum b.hp. of 78 at 3400 r.p.m. The same engine is employed in the six-wheel Model CS-35-T.

Transmissions in the CS-35 and CS-35-T have four forward speeds and one reverse and are equipped with five anti-friction bearings. Clutches are of the single-plate type with built-in vibration dampers and both clutches and transmissions have unusually great torque capacities.

The International dual-performance axle consists of a straddle-mounted spiral-bevel drive pinion, a differential carrier assembly mounted on roller bearings, full-floating axle drive shafts, and the shifting mechanism, fully enclosed in a rigid one-piece cast banjo-type housing. The differential carrier assembly incorporates a spiral-bevel ring gear, a simple supplementary planetary reduction gear set (the low-speed feature), and the usual four-pinion differential unit.

The planetary set introduces a slow-moving reduction between the large bevel gear and the differential unit. The planetary set is locked and does not function in any way when the truck is operating in its high-speed range, the unit simply revolving with the differential ring gear, with the engine drive directly through the drive shaft pinion and the ring gear to the axle shafts.

When the planetary set is free to revolve, it entails but four additional moving parts; namely, four small spur pinion gears. These four spur gears are in constant mesh with an internal gear forged integrally with the ring gear. They are also in constant mesh with a centrally positioned spur gear integral with the shifting sleeve that surrounds the left axle shaft. In this position, the engine drive is through the drive shaft pinion to the ring gear, through the internal gear to the four small pinion gears, and thence through the pinion carrier plate secured to the differential case to the axle shafts.

The planetary reduction gearing is placed in the rear axle in a position to obtain the greatest possible increase of power between the bevel gear and the rear wheels. Situated thus, the planetary gearing brings about a reduction in wheel speed without a reduction in engine speed. This reduction takes place after the power has been transmitted from the engine through the bevel gear. This avoids loss of power through friction and avoids strain on driving parts.

The planetary gearing thus gives a reduction of axle speed for every transmission speed. When in the 5.14-1 (direct or high-speed) ratio and the shifting lever is pulled back, the reduction gears commence to operate at once. The speed of the engine remains constant but the axle speed, and in consequence the wheel speed, is reduced; thus increasing the torque and thereby giving more power.

The same applies to all transmission gears—fourth, third, second, first, and reverse. When the shifting lever is pulled back, a reduction of wheel speeds takes place. When it is pushed forward, the planetary gears cease to operate, wheel speed is increased, and the truck runs in the high-speed range.

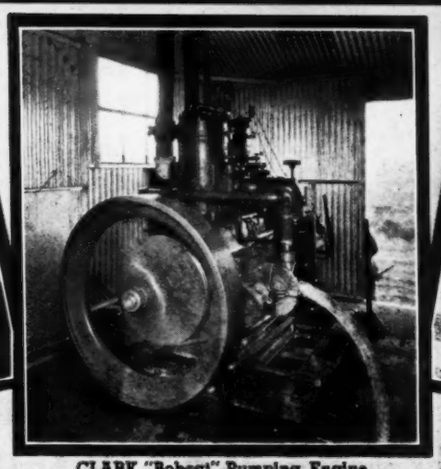
The planetary reduction gears move at axle-shaft speed, which is the slowest moving part of the truck, and they are lubricated with the same oil as the rear axle. The road clearance remains the same, and the added weight is but a few pounds.

The advantages of the International two-speed rear axles may be briefly summed up under eight general headings:

1. Fewer engine revolutions with consequently less engine wear.
2. Quiet, positive shift to either high or low range, regardless of the truck speed.
3. Proper application of power without strain to any chassis part.
4. Eight properly spaced forward speeds; hence more flexible performance and a great saving in gasoline and oil.
5. Two-purpose performance with speed and power combined in a single truck.
6. Better acceleration in traffic with more power on hills. Faster and more economical truck operation.
7. Faster hauling of heavy loads with less cost and with increased profit.
8. Wider range of operation with better performance in meeting various hauling requirements with this dual performance truck.

CLARK VERTICAL
PUMPING ENGINES

CLARK
"Bobcat" Installation
Oklahoma City



CLARK "Bobcat" Pumping Engine
Oklahoma City

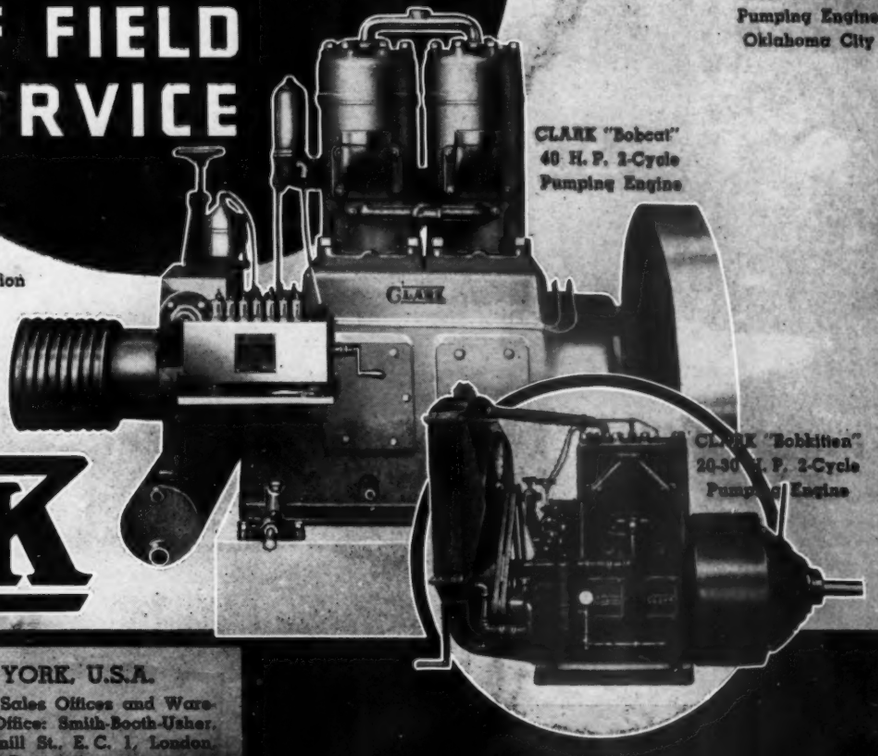
CLARK
"Bobkitten" Installation
East Texas

CLARK "Bobkitten"
Pumping Engine
East Texas

PIONEERS!
proved by
2 YEARS
OF FIELD SERVICE

CLARK "Bobcat"
Pumping Engine
Oklahoma City

CLARK
"Bobcat" Installation
Seminole



CLARK "Bobcat"
40 H. P. 2-Cycle
Pumping Engine

CLARK "Bobkitten"
20-30 H. P. 2-Cycle
Pumping Engine

Further details in 1936 Composite Catalog,
Clark Section, starting Page 371

CLARK

CLARK BROS. COMPANY, OLEAN, NEW YORK, U.S.A.

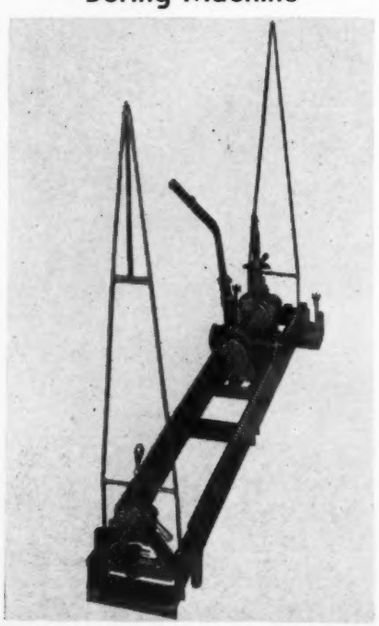
Export Office: 30 Rockefeller Plaza, New York. Midcontinent Sales Offices and Warehouses: Tulsa, Okla., Dallas and Tyler, Tex. West Coast Office: Smith-Booth-Usher, 2001 Santa Fe Av., Los Angeles. Foreign Offices: 72 Turnmill St., E. C. 1, London, England, and 4 Str. Central Poesiss, Bucharest, Roumania.

Regan Narrow Traveling Block

THE increased depth to which wells have been drilled recently has created a demand for heavier equipment. Not only have wire lines been increased from 1 in. and 1⅛ in. to 1¼ in., but it has become necessary to increase the number of lines strung with the traveling block from 10 to 12, requiring use of 6-sheave traveling blocks. Also the greater length of drill pipe handled in the derrick has resulted in occupancy of the available clearance that blocks require for free and unhampered movement. To meet this condition, Regan Forge and Engineering Company engineers have designed a narrow traveling block, Type G. It is equipped with five or six sheaves and is for 500-ton capacity. The sheaves are 48 in. in diameter. The 6-sheave block is but 24½ in. in width, the same size occupied by ordinary 4-sheave blocks. The weight is 13,000 pounds.

Literature describing this new block may be obtained from the manufacturers at San Pedro, California.

Hydrauger Horizontal Boring Machine



THE Hydrauger Corporation, Ltd., has brought out a new model horizontal boring machine. Improvements over previous models include faster boring and greater ease of handling both machine and boring bars, the manufacturers state. The new bars are but 56 in. long and weigh only 17 lb. per section. Improved bar joints are made of alloy-steel, heat treated for hardness and toughness to withstand the greater torque developed by the new 2A-2X model.

Increased size of the airmotor to five hp. results in much faster boring. New type cutting edges on bits and reamers utilize the increased power and higher rotating speed.

The main frame of the machine has increased rigidity and strength. It is four ft. shorter than on previous models of same rated capacity. Required length of ditching to place the Hydrauger in position to bore has been reduced 30 percent.

It is said that this new Hydrauger model can bore horizontal holes up to 14½ in. in diameter a distance of 100 ft. under a paved street or railroad tracks with misalignment of less than 10 inches.

The Hydrauger units are widely used by public utility companies, oil companies, and general contractors for installing water, gas, and oil pipes, without disturbing traffic, pavement, lawns or rails.

National sales are now directed by E. D. Rogers, president of Renco, Inc., engineers. Additional information may be obtained directly from the Hydrauger Corporation, Ltd., 116 New Montgomery Street, San Francisco, California.

Slush Pump Valve

WITH a design that is said to be a radical departure from the conventional type, the U. S. Oil Tool Company, Petroleum Building, Houston, Texas, is offering a slush pump valve of the full hole type that provides a streamlined flow for fluids and is interchangeable for various makes of pumps.

One of the features of this valve is that it is constructed with no stem at either top or bottom. Moreover, the seat is made with no bridge or web and there are no legs in the bottom of the valve. These details provide for a greater opening through the valve and yet permit the same wall thickness and strength of the conventional type, the manufacturers claim. The increased opening decreases the velocity of the fluid at any given pump speed; and this diminishes the erosive wear on the valve and seat besides cutting down the head losses that cause wear on pistons and liners.

The valve is a solid forging with the underside curved to give true streamline flow through it at all velocities. The upper side is made to take a specially designed cup-type rubber insert and holds this rigidly in place to assure perfect seating at all times. The valve and the seat are hardened by heat-treating and with the valve ground to fit after hardening.

The valve guide is a cage screwed on to the seat after the valve is in place. It is made of the finest steel with a stop at the top made at the proper height to allow the seat to open only the necessary distance for economical operation with slippage.

U. S. full hole slush pump valve cross section, showing all construction details

The U. S. Slush Pump Valve combines the best features of the flat-face and beveled-face valves, it is stated. The metal seating surface is beveled and the insert seats on a flat surface. The rubber insert makes contact with the seat on a large flat surface before the metal part of the valve contacts the seat. The insert is heavy enough to absorb practically all the shock and thus eliminates pounding out the metal seat. This insures longer wear and a perfect seal even when foreign matter becomes lodged under the metal part of the seat, it is pointed out.

Inserts also made of Du Prene are supplied for handling crude oils, etc. Further details can be obtained from the manufacturer.

U. S. full hole slush pump valve disassembled, showing the various parts

AQUAGEL-CEMENT *Saves Money* IN THE WELL!

FOR CEMENTING CASING AND RESTORING LOST CIRCULATION

Only *one* or *two* sacks of AQUAGEL per *hundred* sacks of Cement, added to the mixing water, impart a peculiar characteristic to the Cement which prevents it from readily mixing with water, oil or drilling mud. This eliminates the most common cause of unsatisfactory Cement jobs in *Cementing Casing.*

In its plastic state, AQUAGEL-Cement can be pumped directly into a body of water or mud without losing its form or becoming thinned out. Therefore, it *does not channel*, like Neat Cement. Due to the lubricating qualities of the AQUAGEL, it is easier to pump.

When set, AQUAGEL-Cement has *less shrinkage* because no free water settles out; it is much more impermeable because the colloidal particles in the AQUAGEL are dispersed throughout the voids in the Cement, and when proper proportions are used, AQUAGEL-Cement is actually *stronger* than Neat Cement.

Many large companies are using AQUAGEL-Cement as standard practice. Let the BAROID Service Engineer in *your* territory prove its value to *you!*

ORDINARY NEAT CEMENT

1. Loses Free Water
Causes shrinking of cement, permitting passage of formation water through crevise not completely filled.

2. Difficult To Handle
Requires continued high pump pressure to be circulated. Cause of heavy wear on pumps.

3. Flattens Like Water
Seeks its own level, causing high percentage of loss in formation. "Fingers" badly.

4. Easily Contaminated
Pollution by mud and water ruins many neat cement jobs.

5. Poor Metal Protection
Casing and cementing equipment are easily corroded.

AQUAGEL CEMENT

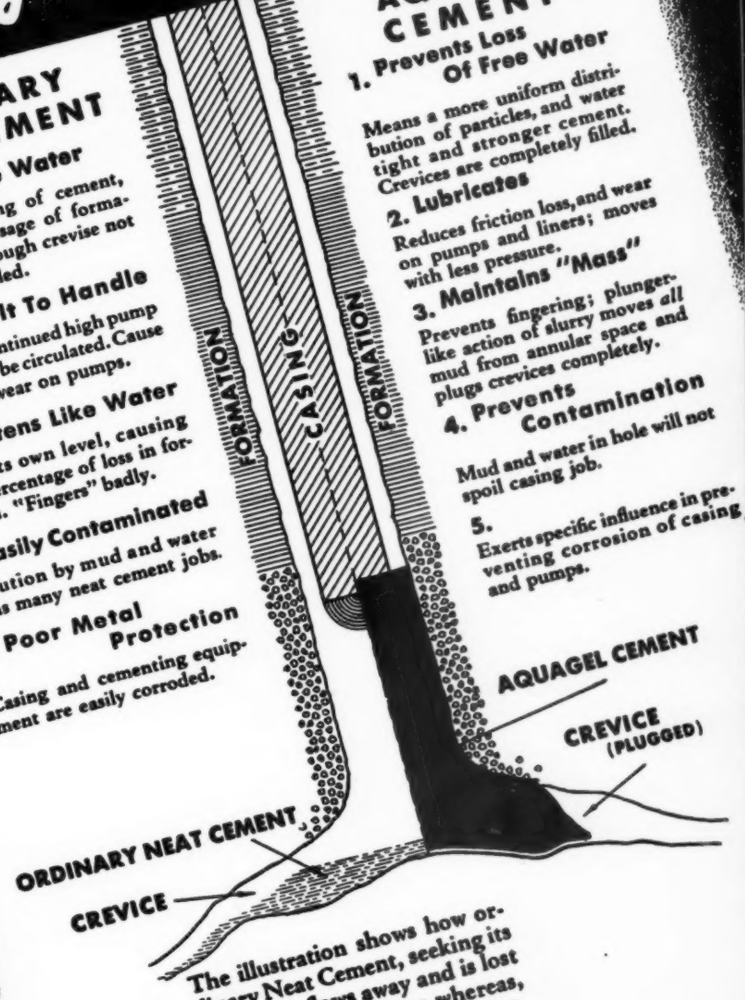
1. Prevents Loss Of Free Water
Means a more uniform distribution of particles, and water tight and stronger cement. Crevices are completely filled.

2. Lubricates
Reduces friction loss, and wear on pumps and liners; moves with less pressure.

3. Maintains "Mass"
Prevents fingering; plunger-like action of slurry moves *all* mud from annular space and plugs crevices completely.

4. Prevents Contamination
Mud and water in hole will not spoil casing job.

5.
Exerts specific influence in preventing corrosion of casing and pumps.



The illustration shows how ordinary Neat Cement, seeking its own level, flows away and is lost in formation crevices; whereas, AQUAGEL-Cement piles up, completely plugging crevice.

BAROID • AQUAGEL • STABILITE
A Complete Drilling-Mud Service

BAROID SALES COMPANY

LOS ANGELES • HOUSTON

NATIONAL PIGMENTS & CHEMICAL COMPANY, ST. LOUIS

Development in B&W Seamless Alloy Tubes

THE Babcock & Wilcox Tube Company, Beaver Falls, Pennsylvania, announces the commercial production of seamless tubes and pipe of a highly-alloyed steel containing 25 percent chromium and 20 percent nickel. These products are available hot-finished in sizes up to six inches outside diameter and cold-drawn in smaller sizes. The new alloy is being marketed under the trade name B&W Croloy 25-20. It has been available for high-temperature application in sheet, plate, rods, and castings, but has not, heretofore, been made available in seamless tube form except through a tedious forging and boring process.

Grant Hydrostatic Perforation Cleaner

FEATURING an advanced, patented construction that is said to eliminate close fitting valves and increase the capacity of the loading chamber, the Grant Hydrostatic Perforation Cleaner is now offered to the oil industry either for outright sale or on a service basis.

The operation of the hydrostatic cleaner is based on the difference between the hydrostatic pressure in the well and the atmospheric pressure at the surface. The tool consists of a fluid-tight hollow tube of optional length, with a connection for attaching to a rope socket at its upper end. The lower end of the tube or loading chamber is closed by a ball check valve that permits material to enter the chamber but prohibits its escape except through the unloading port. Slightly below the check valve is a sliding disc holder for receiving the patented concave composition sealing disc that seals off the empty loading chamber against the well pressure while the perforation cleaner is being run into the hole.

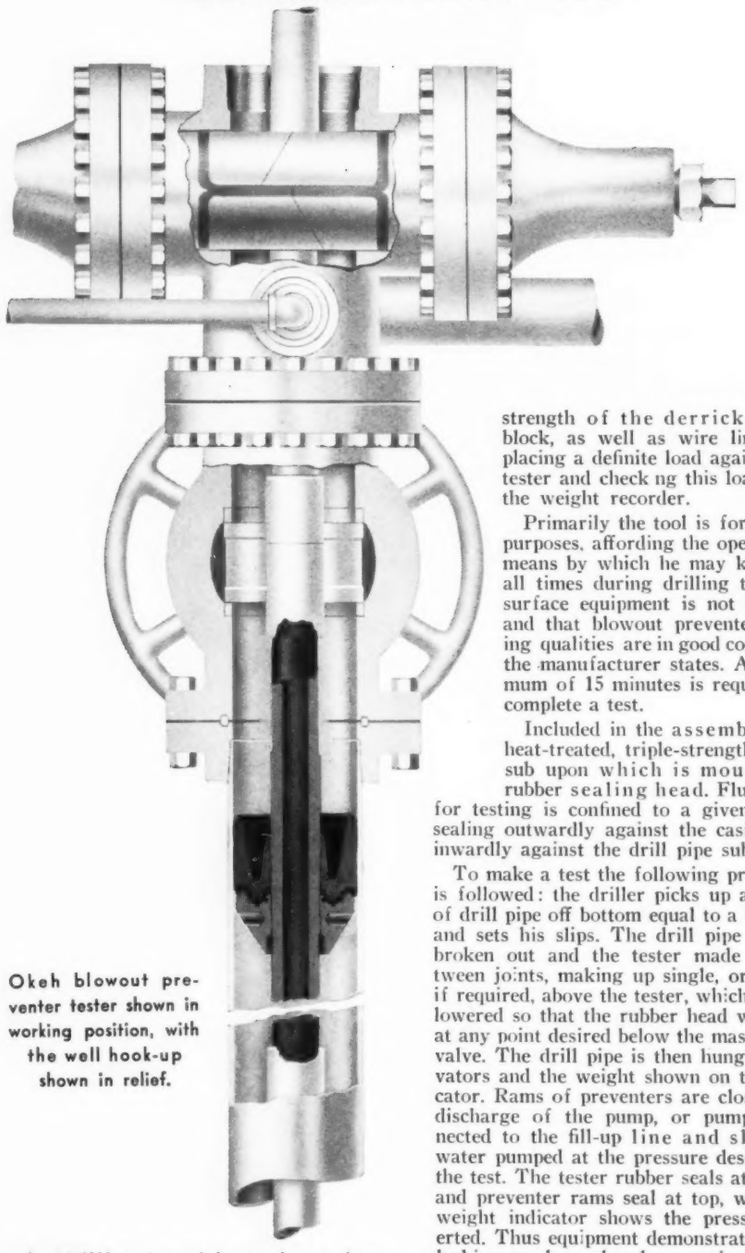
An ingenious but simple mechanism is employed to break the sealing disc when the perforation cleaner reaches the desired point in the well. A double swab rubber assembly, slidable on the tube, is held in an upward position by friction of the rubbers against the casing while running in the hole. When the perforation cleaner reaches the point at which it is desired to clean the perforations, the tool is raised slightly until the lower shoulder of the swab rubber assembly, which remains stationary in the pipe, depresses the tripping sleeve. This releases the locking dogs that hold the disc-breaker spring compressed and snaps the serrated point of the disc breaker sharply against the composition sealing disc, shattering it.

Upon the disc being shattered, the fluid in the space between the swab rubbers and behind the perforated pipe rushes into the loading tube, carrying with it the material that clogged the perforations and the space between the pipe and the wall of the hole. The sudden surging of the fluid is said effectively to dislodge sand, mud, asphalt, and paraffin. The fact that the undesirable material is actually removed from the hole is claimed as a particularly valuable phase of the operation of the Grant Hydrostatic Perforation Cleaner. Emptying the loading tube when the tool is brought to the surface is accomplished by means of a door in the side of the chamber. The evacuation of the contained material is facilitated by air trapped in the upper part of the chamber and compressed by the incoming fluid when the disc is broken.

The manufacturer claims as an outstanding feature of this perforation cleaner the absence of pushrods or other mechanism within the loading chamber. Thus, the entire capacity of the tube is available to receive material to be removed from the well. The use of two swab rubbers in an opposed position effectively confines the surging action to a limited portion of the pipe. Successive runs to various depths enable the operator to clean any length of perforated pipe that may be in the well.

Further information, requests for prices and orders for sales or service may be addressed to the Grant Oil Tool Company at Los Angeles, California, or Houston, Texas.

Okeh Blowout Preventer Tester



Okeh blowout preventer tester shown in working position, with the well hook-up shown in relief.

A NEW tool, used for testing to determine leaks at joints or fittings above the top of surface casing, has been announced by the Texas Rubber and Specialty Corporation, Houston, Texas. Known as the Okeh blowout preventer tester, it also can be employed to test the strength of the derrick crown block, as well as wire lines, by placing a definite load against the tester and checking this load with the weight recorder.

Primarily the tool is for safety purposes, affording the operator a means by which he may know at all times during drilling that his surface equipment is not leaking and that blowout preventer sealing qualities are in good condition, the manufacturer states. A maximum of 15 minutes is required to complete a test.

Included in the assembly is a heat-treated, triple-strength steel sub upon which is mounted a rubber sealing head. Fluid used for testing is confined to a given space, sealing outwardly against the casing and inwardly against the drill pipe sub.

To make a test the following procedure is followed: the driller picks up a length of drill pipe off bottom equal to a thribble and sets his slips. The drill pipe is then broken out and the tester made up between joints, making up single, or double if required, above the tester, which is then lowered so that the rubber head will stop at any point desired below the master gate valve. The drill pipe is then hung on elevators and the weight shown on the indicator. Rams of preventers are closed, and discharge of the pump, or pumps, connected to the fill-up line and slush or water pumped at the pressure desired for the test. The tester rubber seals at bottom and preventer rams seal at top, while the weight indicator shows the pressure exerted. Thus equipment demonstrated to be leaking can be replaced or repaired before damage occurs.

The drill pipe sub used is of standard size, having standard 4-in. drill pipe thread. Use of tool joint subs makes it possible for the tester to be adapted to any size drill pipe.

BEFORE ABANDONING WELLS

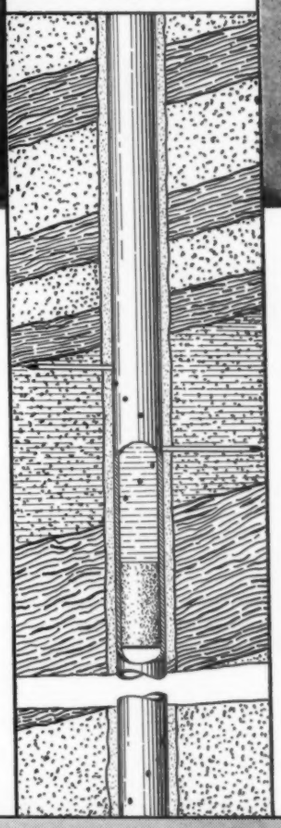
Gun-Perforate FOR POSSIBLE PRODUCING STRATA

NO 1

of a Series of Gun Perforator Applications

Meet "Perforating Pete," who will discuss these applications each month.

Diagram below shows typical well section, in which one zone has been Gun-Perforated, depleted and plugged. . . The zone above has also been Gun-Perforated and is ready for test.



SAYS "PERFORATING PETE":

"Don't ever abandon a well without exhausting both its PROBABILITIES and its POSSIBILITIES.

"If your core records or correlation charts show PROBABLE productive zones, it's certainly logical to plug-back to each of these zones, Gun-Perforate, test and produce if you get oil.

"But even if your records are incomplete—as they usually are in your old 'boom period' wells—it's relatively inexpensive to test all POSSIBLE zones, too, before giving up the ghost.

"The usual practice is to plug-back, then have us Gun-Perforate and test in short sections of from 10 to 30 feet, shooting one hole per foot. . . If you hit a wet zone, cement off and continue to explore until you locate a zone that's commercially productive.

"Incidentally, you can safely use our Gun Perforator method even in old wells where your casing is in doubtful condition and where the derrick will not stand jarring.

"As for results, of course there's the element of chance found in all oilfield operations, but by and large, experience in all major fields has proved that systematic plug-back campaigns really 'pay out'."

NOTE: This is the first of a series of practical Gun Perforator Applications, which will be published monthly. . . Next month "Perforating Pete" will discuss the desirability of cementing blank liners in new wells.

NOTE: Devices used and Method of Operation are fully protected by U. S. Patent No. 1,582,184 issued April 27, 1926, and other U. S. and Foreign Patents Pending.

Tomorrow's Tools—Today!

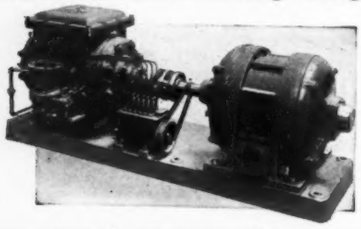
THE **LANE-WELLS** CO.

Gun Perforator Service

LOS ANGELES • HOUSTON • OKLAHOMA CITY • TULSA • NEW YORK

Allis-Chalmers "Ro-Twin" Compressor

ALLIS-CHALMERS Manufacturing Company, Milwaukee, Wisconsin, announces a new line of two-stage sliding-vane rotary air compressors for pressures up to 100 lb. gauge. The design is unique in that both stages as well as the intercooler are contained in a single casing. This new type of compressor is designated the "Ro-Twin." Compared with the usual design of two-stage rotary having two separate cylinders, it offers the advantages of greatly reduced length and floor space, less weight, only one stuffing box and one coupling, no external air piping between stages to keep tight, and a simpler lubrication system, the manufacturers claim. Having only two bearings, and one flexible coupling, alignment is easily maintained; air delivery is free from pulsations and the operation smooth, quiet, and vibrationless, it is stated.

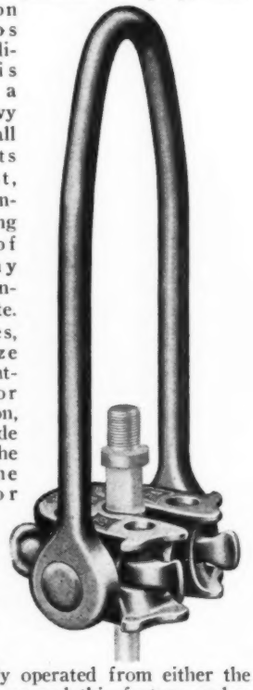


The design is made possible through the employment of the wear-eliminating "floating rings" that have been a feature of Allis-Chalmers sliding vane rotary compressors and vacuum pumps.

A complete line of "Ro-Twins" has been developed, from 20 hp., 1740 r.p.m. to 100 hp., 690 r.p.m., for actual air deliveries from 69 cu. ft. per min. to 412 cu. ft. per min. at 100 lb. gauge air pressure.

Dual Latch Rod Elevators

A new rod elevator with front and rear latch control has been designed by the Byron Jackson Company, 2150 East Slauson Avenue, Los Angeles, California. It is made in both a light and heavy type to meet all requirements for the fast, safe, and convenient handling of strings of rods of any length, the manufacturers state.



The latches, ample in size and conveniently located for easy operation, do not protrude to catch in the clothing of the operator or hang up on any object while the elevator is being raised or lowered, it is stated. The latch controls are easily operated from either the front or the rear and this feature makes it equally convenient to handle rods whether they are in hangers or on the ground. Once the elevator is snapped around the rod, any movement of the rod against the latches tends to close them more securely. The danger of dropping the string is thus eliminated, since the latches must be opened by the operator before the rod can be released, the makers state.

The elevator is made with a solid, one-piece body and has top and bottom bearing surfaces designed to fit the taper of all rods. Heat treatment of the entire body and of the latches insures maximum wearing qualities of these important bearing surfaces and of the trunnion pins that support the bail. Large diameter body trunnions are upset to retain the alloy steel bail securely in place. The mouth of the elevator is tapered and widened toward the front to assure easy entrance of the rod. Both top and bottom surfaces are flat to allow the elevator to rest firmly on its base without tipping. Its balance eliminates possibility of kinking or distorting the rods which always hang in a true vertical position, it is pointed out.

As an aid to convenient operation, a dog is provided on each side of the body to hold the bail up at the proper angle for an easy pick-up with the hook. Standard length of bail is 18 inches.

Further details will be furnished by the manufacturer.

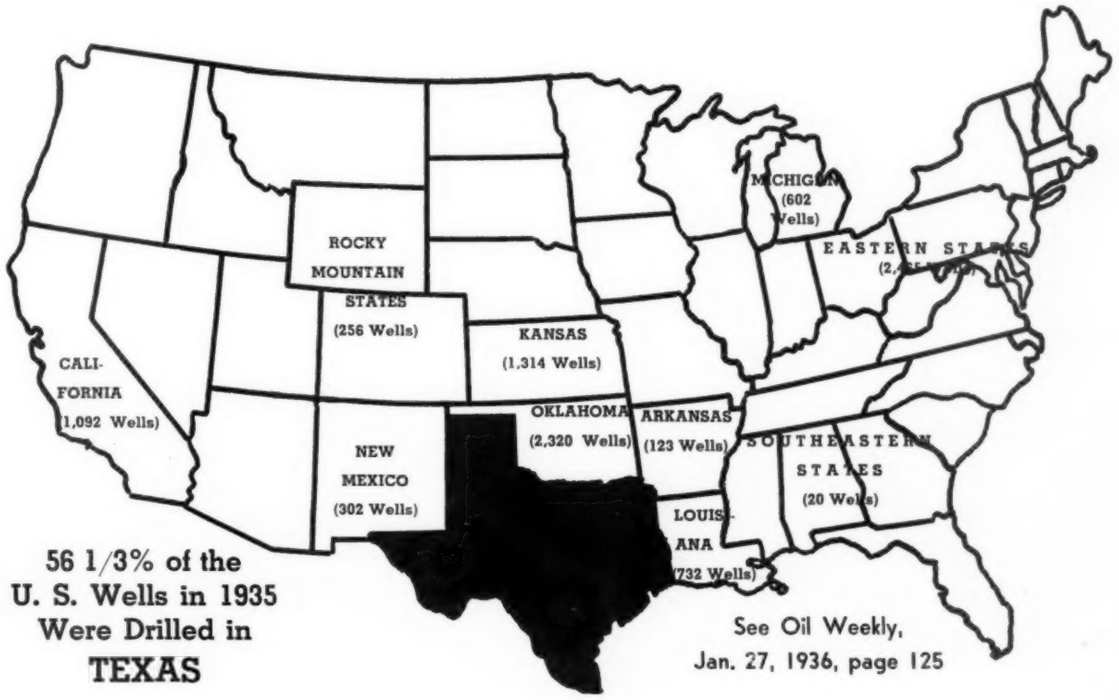
The third Arabian shipment, shown here, includes 3 O-C-T Type "D" Blowout Preventers, 45 Reducing Bushings, 45 Packoff Assemblies, 9 Wear Rings and 9 extra Eccentric Band Springs

The first of these three orders for O-C-T Type "D" preventers for shipment to Arabia followed a check over long periods of the outstanding performance in Mid-Continent fields.

This inexpensive preventer is permitting the operator to rotate or work pipe up and down, keeping drill pipe in motion while fighting the well with heavy mud. This eliminates the sticking of drill pipe, the cost of which would be many times over the cost of the preventer.

A COPY OF OUR CATALOG WILL BE SENT YOU UPON REQUEST

EXHIBIT WHERE YOUR ACTIVE MARKET IS!



56 1/3% of the U. S. Wells in 1935 Were Drilled in TEXAS

See Oil Weekly, Jan. 27, 1936, page 125

OIL EQUIPMENT AND ENGINEERING EXPOSITION

Here is that *one occasion* of the year where the BUYER CALLS ON THE SALESMAN! Here will be displayed, for the convenience of the buyer and at a profit to the exhibitor, the greatest array of Oil Industry Equipment ever shown under one roof. NEW EQUIPMENT . . NEW METHODS.

See for yourself, from actual statistics above, that this Exposition is being held in the very center of the World's hot spot of activity . . the heart of the manufacturer's market . . the center of interest for the operator.

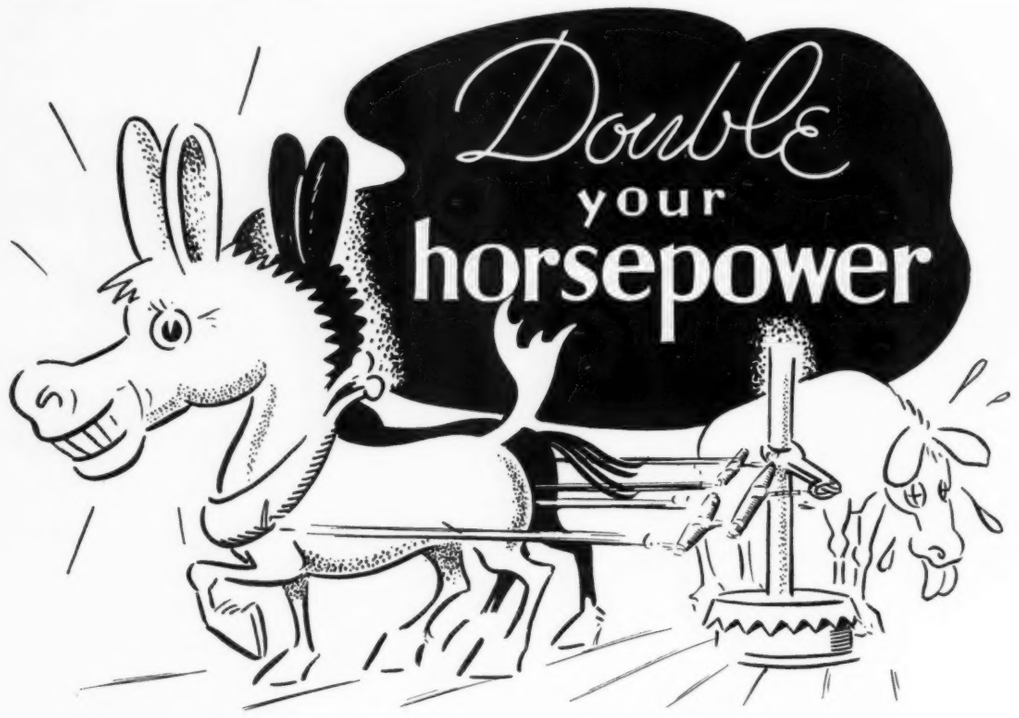
Manufacturers still have nearly two months to plan and prepare their exhibits for the thousands of key men who will attend. Write *today* for exhibit space and FREE ADMISSION TICKETS!

HOUSTON, TEXAS

Heart of the Industry's Activity!

APRIL 20-25

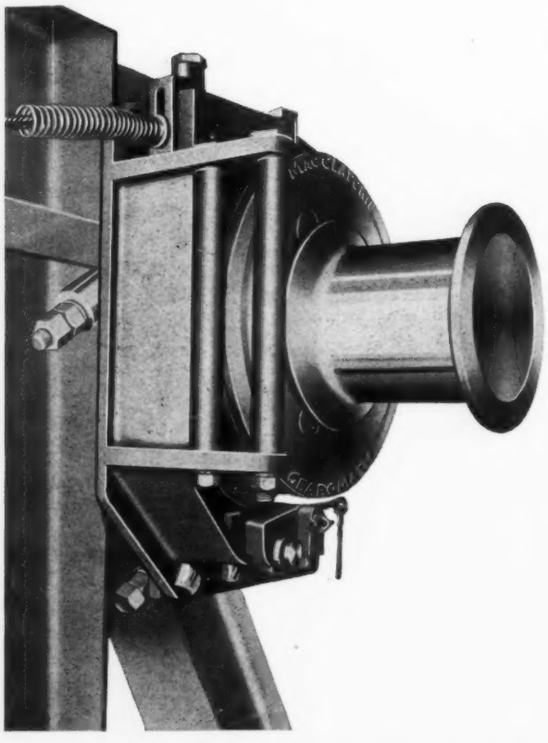
Complete Exhibits of Equipment for DRILLING, PRODUCTION, PIPE LINES, REFINING AND GASOLINE PLANTS . . .



with the Geared **MacClatchie**

"Gearomatic"

CATHEAD

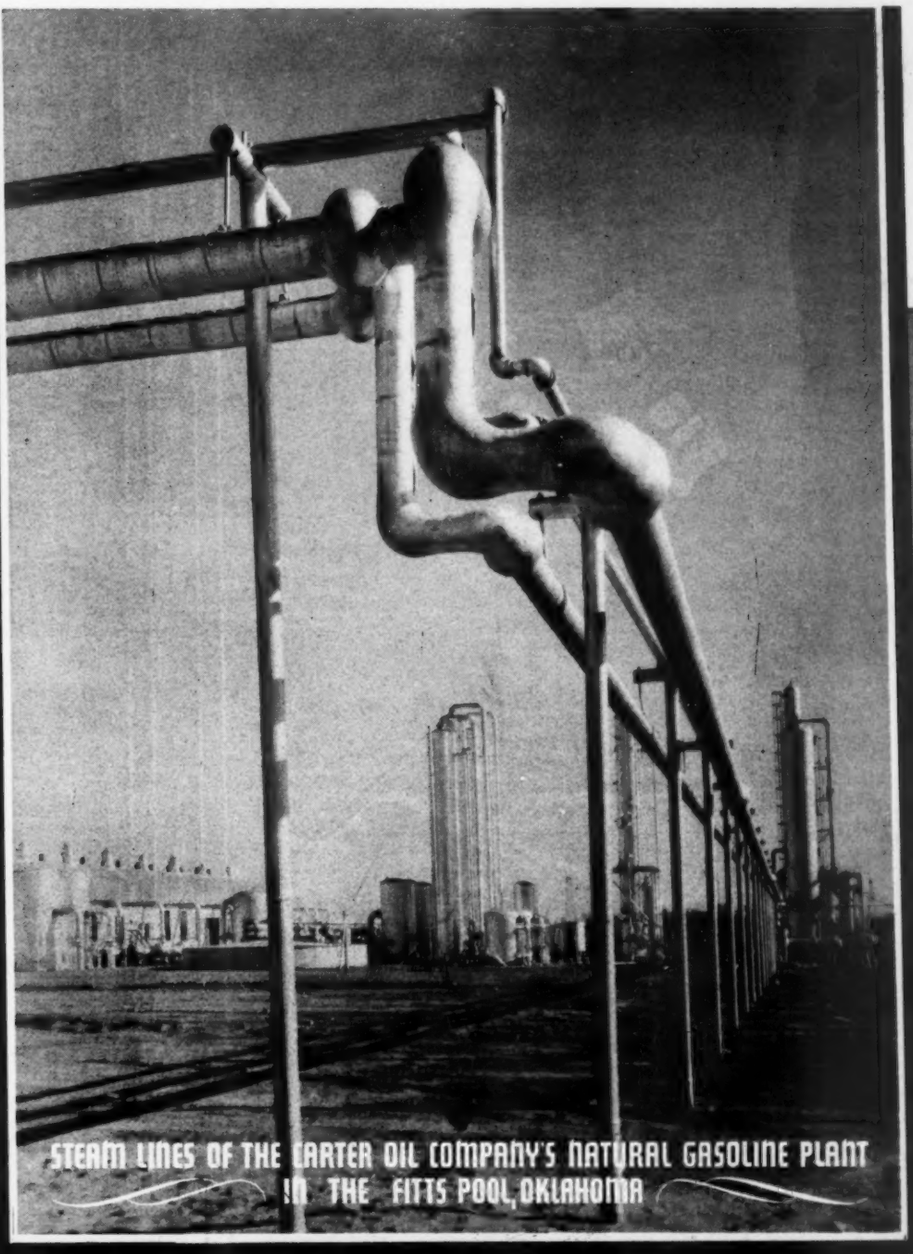


A great deal of time is lost with other Automatic catheads due to the fact that every so often they run into extremely tight joints that can't be broken or it takes two or more pulls in order to break them. This never occurs with the *Geared* MacClatchie Cathead, as it has twice the power of other catheads. While it gives twice the power its pull is twice as slow, which eliminates damage to tongs, tong dies, the pipe and other equipment. Even with these two distinct advantages the design has not sacrificed safety or simplicity. There is no friction clutch or large costly bearings in its construction. A positive kick out makes but one revolution, which insures safety.

One Alemite nipple greases the entire Cathead. Without exception every superintendent, tool pusher, driller and roughneck that has used MacClatchie Gearomatic Catheads claim they are superior to any joint-breaking device they have ever used. Absolutely guaranteed to break all 8" drill pipe joints and all bits and drill collars with ease. Already adopted by several major companies as standard equipment. It's the only modern cathead for modern deep drilling and tight joints.

MacCLATCHIE
MANUFACTURING COMPANY
COMPTON, CALIF. HOUSTON, TEXAS

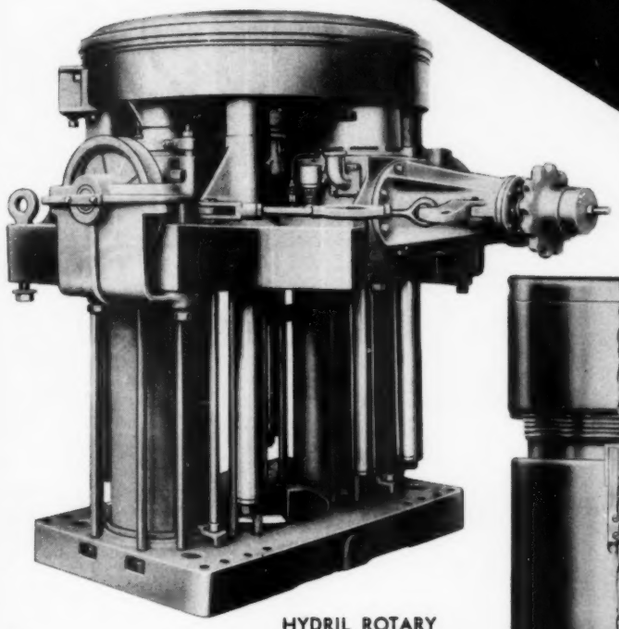
PICTORIAL PETROLEUM



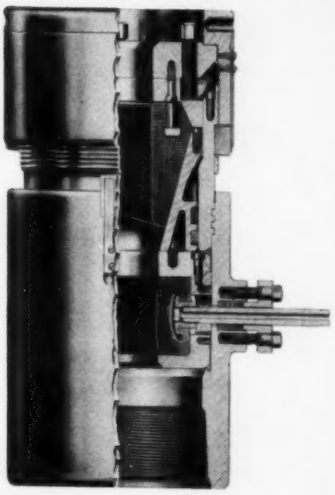
STEAM LINES OF THE CARTER OIL COMPANY'S NATURAL GASOLINE PLANT IN THE FITTS POOL, OKLAHOMA

A REGULAR FEATURE OF THE PETROLEUM ENGINEER

Install HYDRIL Controlled Pressure DRILLING EQUIPMENT Before YOU REACH THE PRESSURE ZONE



HYDRIL ROTARY
equipped for chain drive from any conventional draw works. Quickly installed in place of flat rotary. (Patented.)



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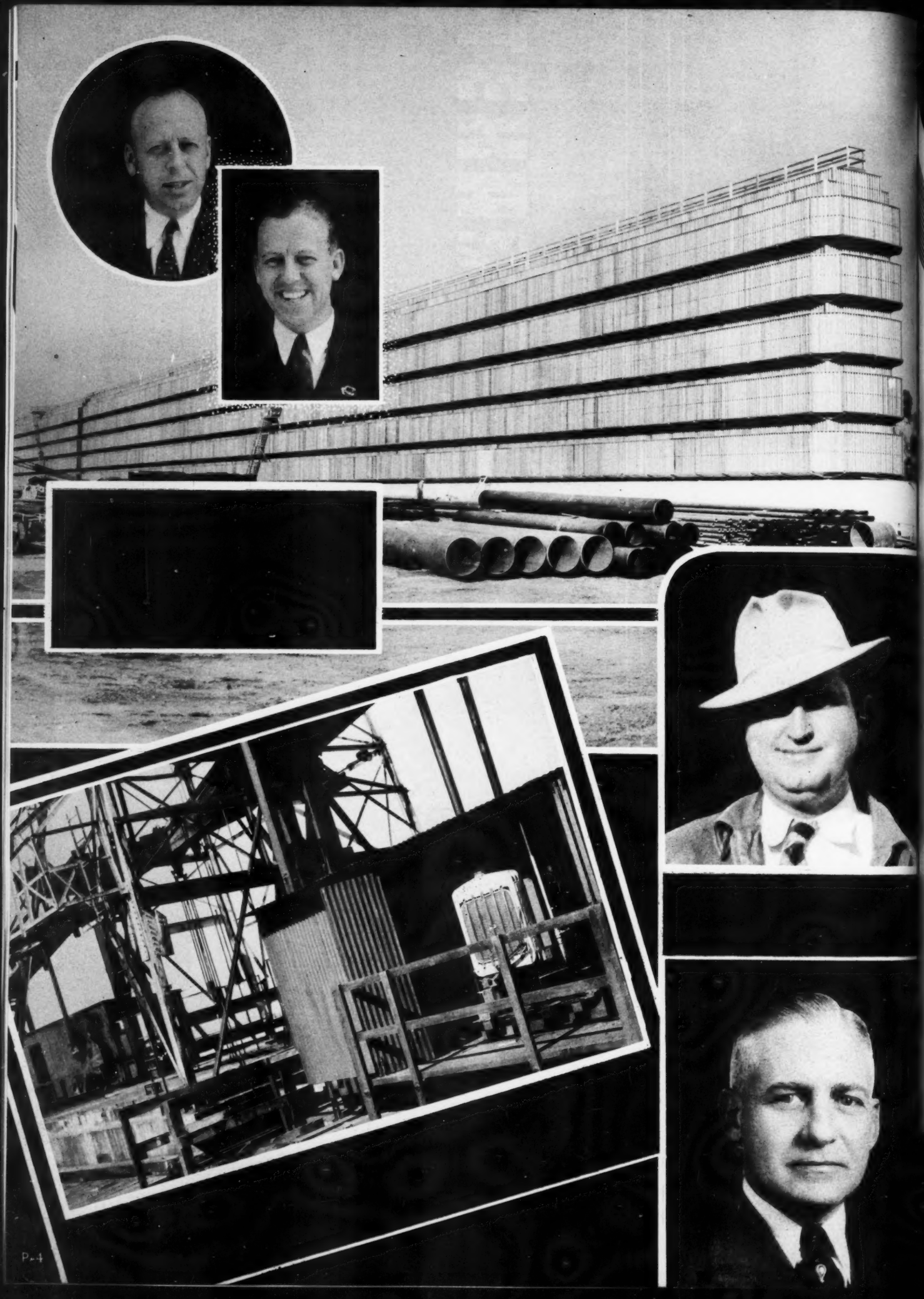

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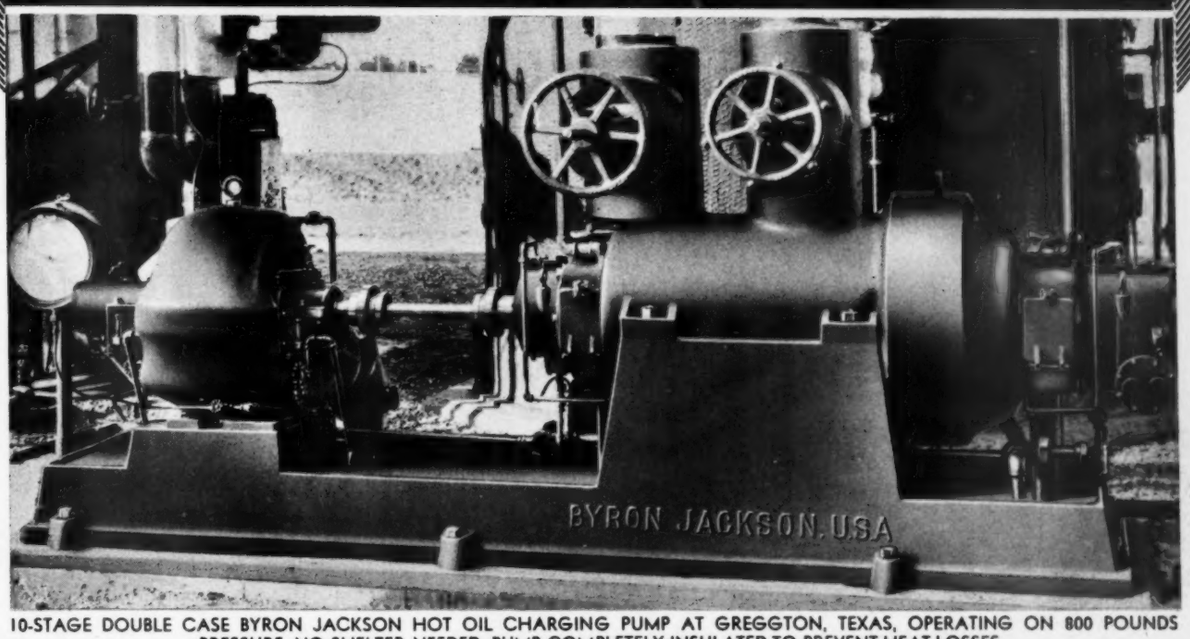

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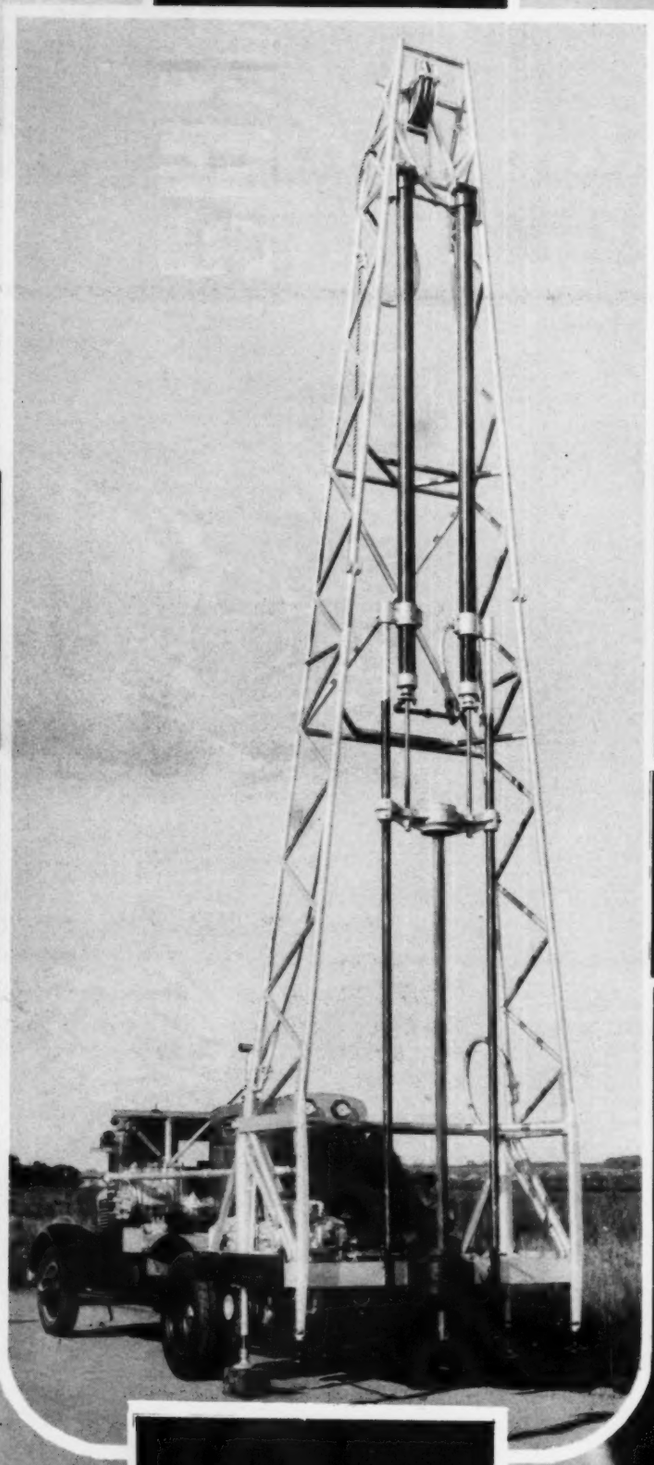

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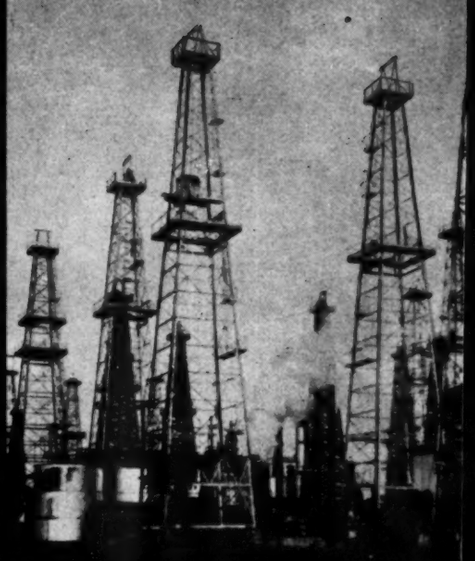

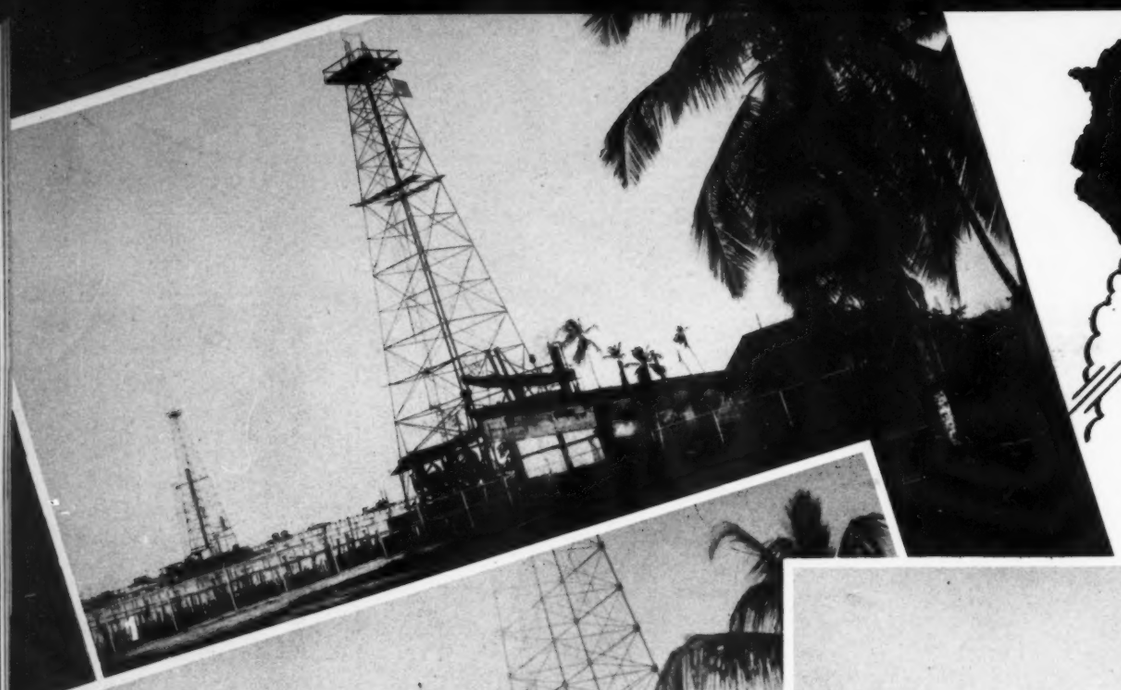

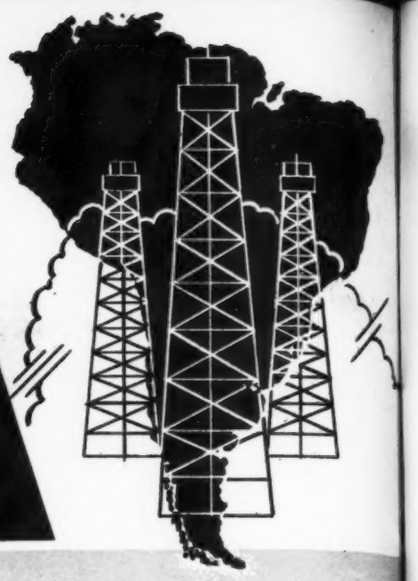

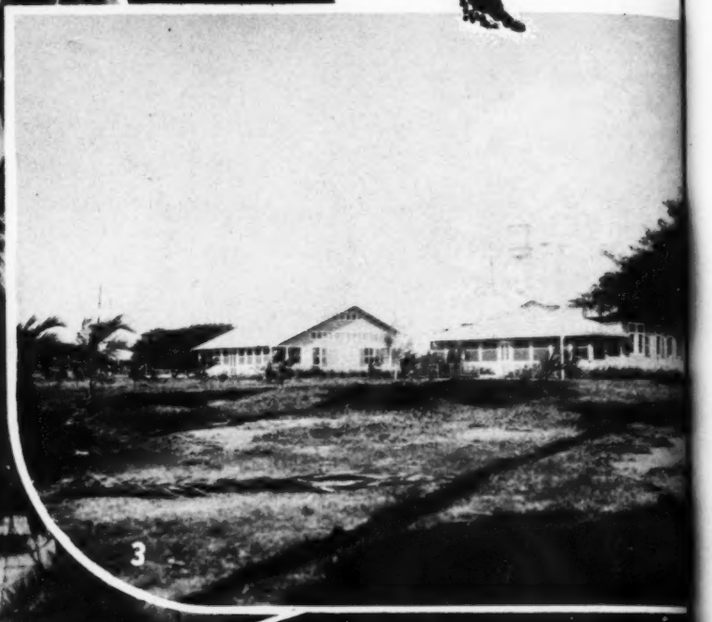

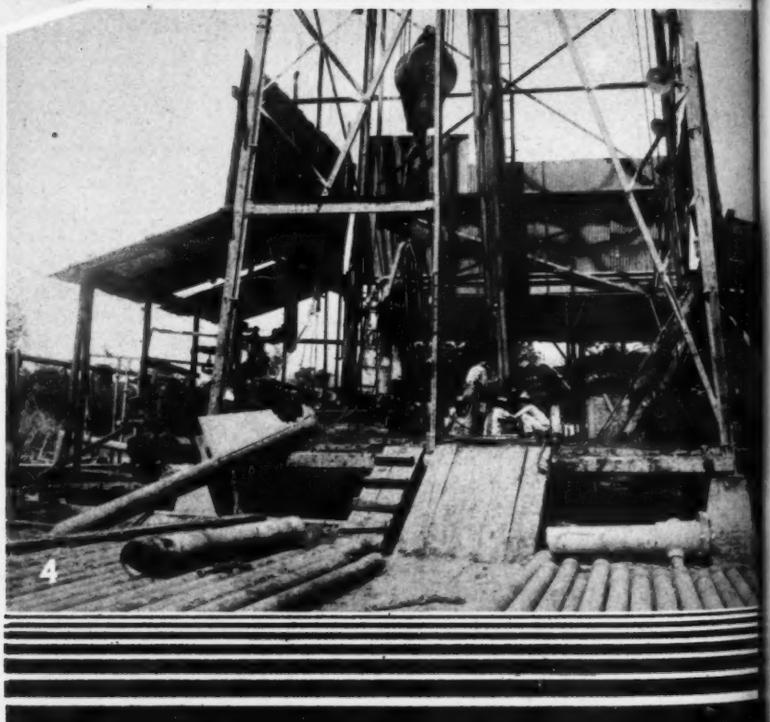

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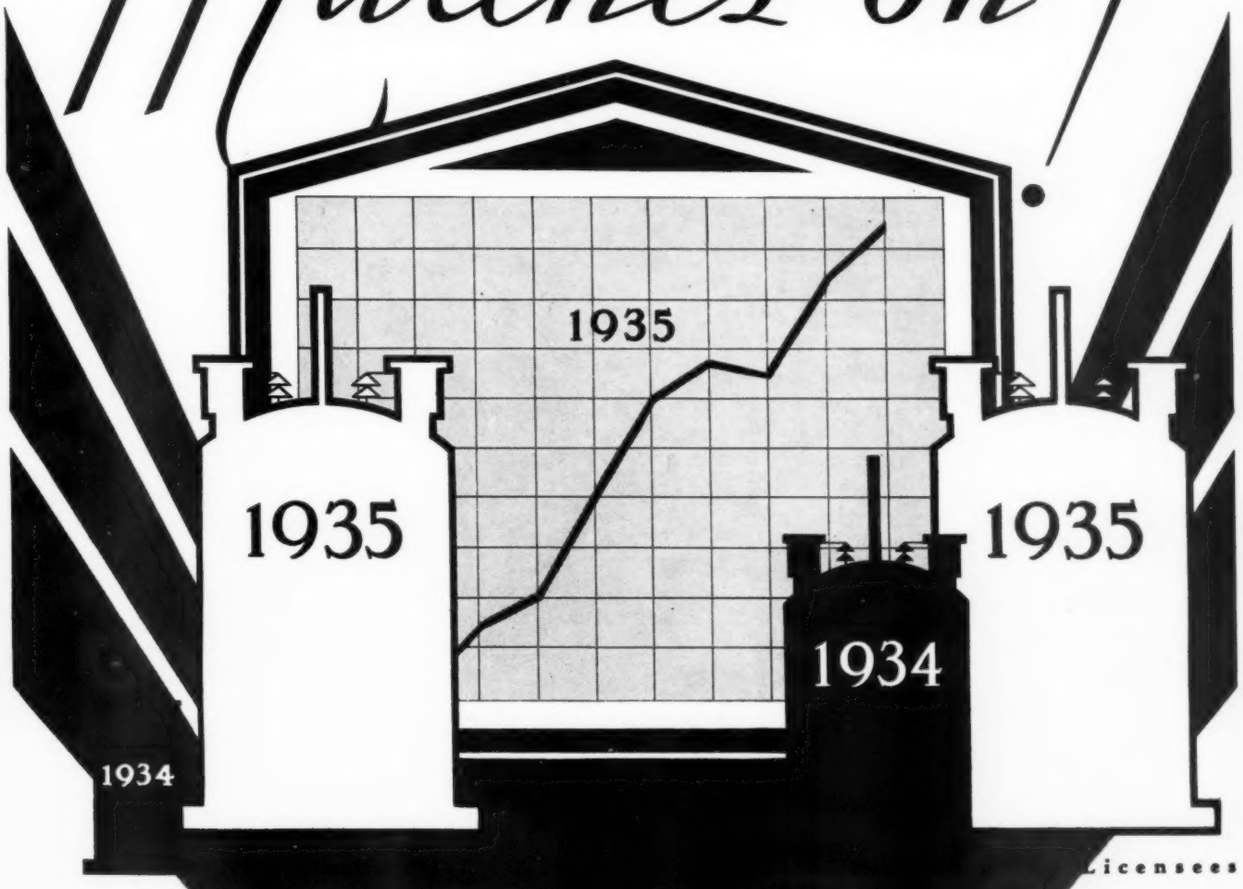

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The Electrical Process for Dehydrating Crude Oil Emulsions

Removal of Hydrogen Sulphide from Kerosene by Vacuum-Flashing

By GEO. M. WOODS

IN the production of kerosene from crude oils the kerosene cut is obtained by distillation of the crude oil, and usually contains an appreciable amount of hydrogen sulphide. Especially is this true if the kerosene cut is taken off under atmospheric pressure. If the kerosene is taken off under vacuum, as is seldom the case, then, of course, the amount of hydrogen sulphide contained in the kerosene will be small. This hydrogen sulphide is usually removed by means of a caustic wash ahead of the doctor sweetening operation. The amount of hydrogen sulphide contained in the kerosene cut from different crudes, varies from practically nothing up to 0.70 or more lb. per barrel. In Table I are given inspection data on four typical kerosene cuts from various crude sources. The hydrogen sulphide content of these kerosenes is given in lb. of hydrogen sulphide per bbl. of kerosene. These kerosenes were all produced by straight distillation methods.

TABLE I

Inspection Data on Kerosenes from Different Crudes

Stock, Number Crude Source	1 Coastal Texas	2 Mid-Continent	3 Panhandle Texas	4 West Texas
Gravity, deg. A.P.I. . .	38.6	41.4	41.5	42.0
I.B.P., deg. fahr. . . .	381	379	386	388
F.B.P., deg. fahr. . . .	525	563	585	576
Hydrogen Sulphide Content, lb./bbl. . . .	0.12	0.25	0.41	0.64

The hydrogen sulphide removed by caustic washing takes place according to the following equation:

$$H_2S + 2NaOH \rightarrow Na_2S + 2H_2O$$

Hydrogen Sulphide + Sodium Hydroxide → Sodium Sulphide + Water

Thus for every lb. of hydrogen sulphide removed by means of caustic 2.35 lb. of caustic is used. With the cost of caustic at 2.5 cents per lb. the cost of the caustic to remove the hydrogen sulphide from 1000 bbl. of each of the above four kerosene samples would be:

Stock, Number Crude Source	1 Coastal Texas	2 Mid-Continent	3 Panhandle Texas	4 West Texas
Cost of Caustic to Remove Hydrogen Sulphide from 1000 Bbl. of Kerosene . . .	$7.05	$14.70	$24.10	$37.60

Because of the high caustic consumption in removing the hydrogen sulphide by caustic-washing, the possibility of removing the hydrogen sulphide, or at least the greater portion of it from the kerosene by vacuum-flashing was studied experimentally.

The apparatus used in studying the possibility of removing hydrogen sulphide from kerosene by vacuum-flashing consisted of a charge drum, a flashing flask (3-liter glass), a pump, receiver, manometer, and a vacuum pump. A diagram of the apparatus is shown in Fig. I. The raw distillate con-

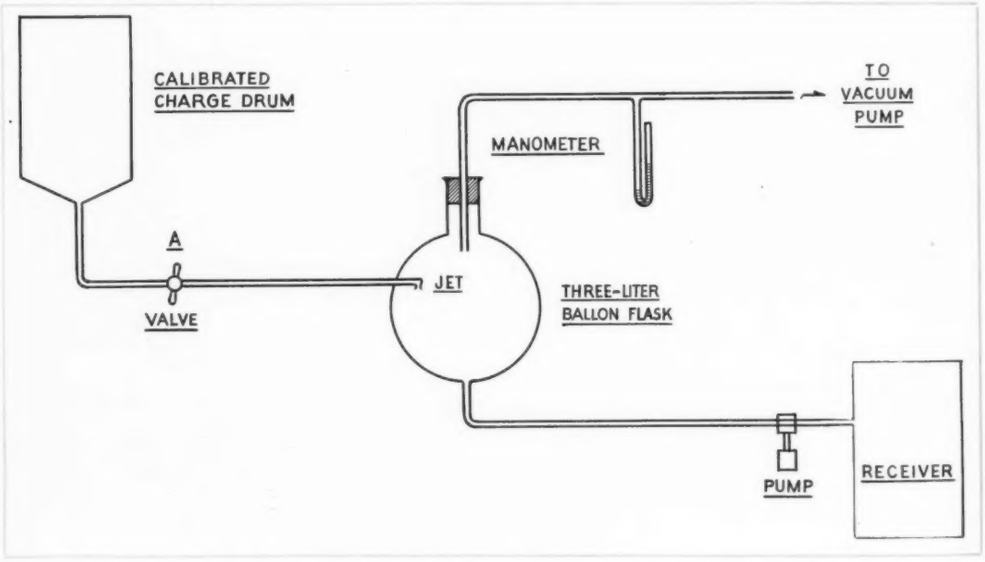

Fig. I. Diagram of vacuum-flashing experimental apparatus to remove hydrogen sulphide from kerosene

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taining hydrogen sulphide was placed in the charge drum, and the vacuum pump adjusted to maintain a fixed vacuum on the flashing flask. The valve A on the charge line was slightly opened so that a steady stream of kerosene was injected into the flask. The charge rate was adjusted by means of the lowering of the liquid level in the calibrated charge pot. When a sufficient level had been obtained in the flask the bottoms pump was started up, which removed the kerosene from the flask at the same rate it enters. The quantity of hydrogen sulphide in the kerosene was measured by adding excess caustic solution to the kerosene, and titrating the caustic back with hydrochloric acid. Runs were made using charge rates of 100, 200, and 300 cc. per minute under absolute pressures of 20 and 40 mm. of mercury at room temperatures (67 to 82 deg. fahr.), on the four raw charge stocks. The complete results including the amount of hydrogen sulphide remaining in the kerosene after flashing are given in Table II.

TABLE II

Removal of Hydrogen Sulphide from Kerosene by Flashing Under Reduced Pressure

Stock Number	Charge Rate, cc. Per Minute	Absolute Pressure, mm. of Mercury	Hydrogen Sulphide Content of Charge Lb. per Bbl.	Hydrogen Sulphide Content After Flashing Lb. per Bbl.	Hydrogen Sulphide Removed, Percent of Total
1	100	20	0.12	0.025	79
1	100	40	0.12	0.036	70
1	200	20	0.12	0.032	73
1	200	40	0.12	0.041	66
1	300	20	0.12	0.038	68
1	300	40	0.12	0.046	62
2	100	20	0.25	0.035	86
2	100	40	0.25	0.040	84
2	200	20	0.25	0.038	85
2	200	40	0.25	0.046	82
2	300	20	0.25	0.042	83
2	300	40	0.25	0.067	73
3	100	20	0.41	0.060	85
3	100	40	0.41	0.086	79
3	200	20	0.41	0.063	85
3	200	40	0.41	0.085	76
3	300	20	0.41	0.072	82
3	300	40	0.41	0.089	77
4	100	20	0.64	0.032	95
4	100	40	0.64	0.046	93
4	200	20	0.64	0.036	94
4	200	40	0.64	0.049	92
4	300	20	0.64	0.038	94
4	300	40	0.64	0.054	91

It will be noticed from the data given in Table II, that 75 percent or more of the hydrogen sulphide can be removed from kerosene very easily by means of vacuum-flashing. It further will be noticed, as would be expected, that the better the vacuum the more hydrogen sulphide for a given charge rate and the slower the charge rate the more hydrogen sulphide removed. It appears from the data that the hydrogen sulphide remaining in the vacuum-flashed kerosene depends upon the absolute pressure under which it was flashed.

The kerosene loss due to vacuum-flashing was determined and found to be from 0.02 to 0.05 per cent of the volume of the kerosene charged, depending on the absolute pressure under which the vacuum-flashing operation was carried out and on the physical characteristics of the kerosene stock.

From the laboratory data obtained it appears that the hydrogen sulphide present in kerosene could be lowered to around 0.05 lb. per bbl. by means of vacuum-flashing. This remaining hydrogen sulphide would have to be removed with caustic, and so the vacuum-flashing operation could not be substituted for the caustic-washing operation. Therefore, any possible advantage of vacuum-flashing kerosene to remove the contained hydrogen sulphide must come from the savings due to the reduction in the quantity of caustic required to neutralize the hydrogen sulphide. On the basis of caustic at 2.5 cents per lb. the cost of caustic to neutralize the hydrogen sulphide in 1000 bbl. of kerosene containing various amounts of hydrogen sulphide follows:

Contained Hydrogen Sulphide, Lb. per Bbl.	Caustic Cost per 1000 Bbl. of Kerosene (Caustic 2.5 Cents per Lb.)
0.1	$ 5.88
0.2	11.75
0.3	17.63
0.4	23.50
0.5	29.38
0.6	35.26
0.7	41.13
0.8	47.00
1.0	58.75

The cost of caustic necessary to neutralize 1000 bbl. of a kerosene stock containing 0.05 lb. of hydrogen sulphide per bbl. would be $2.94. This amount corresponds to the cost of caustic necessary to neutralize the vacuum-flashed kerosene stock. The kerosene loss due to the flashing operation amounts to less than 0.05 percent or less than 0.5 bbl. per 1000 bbl. of kerosene flashed. With kerosene at five cents per gal. this kerosene loss would amount to less than $1.05 per 1000 bbl. of kerosene flashed.

The size of plant scale apparatus for removing hydrogen sulphide by vacuum flashing kerosene may be calculated from the laboratory data. Thus a charge rate of 200 cc. per minute into a 3-liter flask corresponds to a charge rate of 1000 bbl. per day into a 10.5-bbl. steel drum. The cost of a 10.5-bbl. steel drum built to withstand reduced pressure, equipped with a steam vacuum jet, charge and discharge lines would be relatively cheap, and could probably be constructed at most refineries from equipment already on hand.

It would appear that vacuum-flashing kerosene to remove hydrogen sulphide would be well worth while in refineries processing kerosene that contains as much as 0.4 lb. or more of hydrogen sulphide per barrel.

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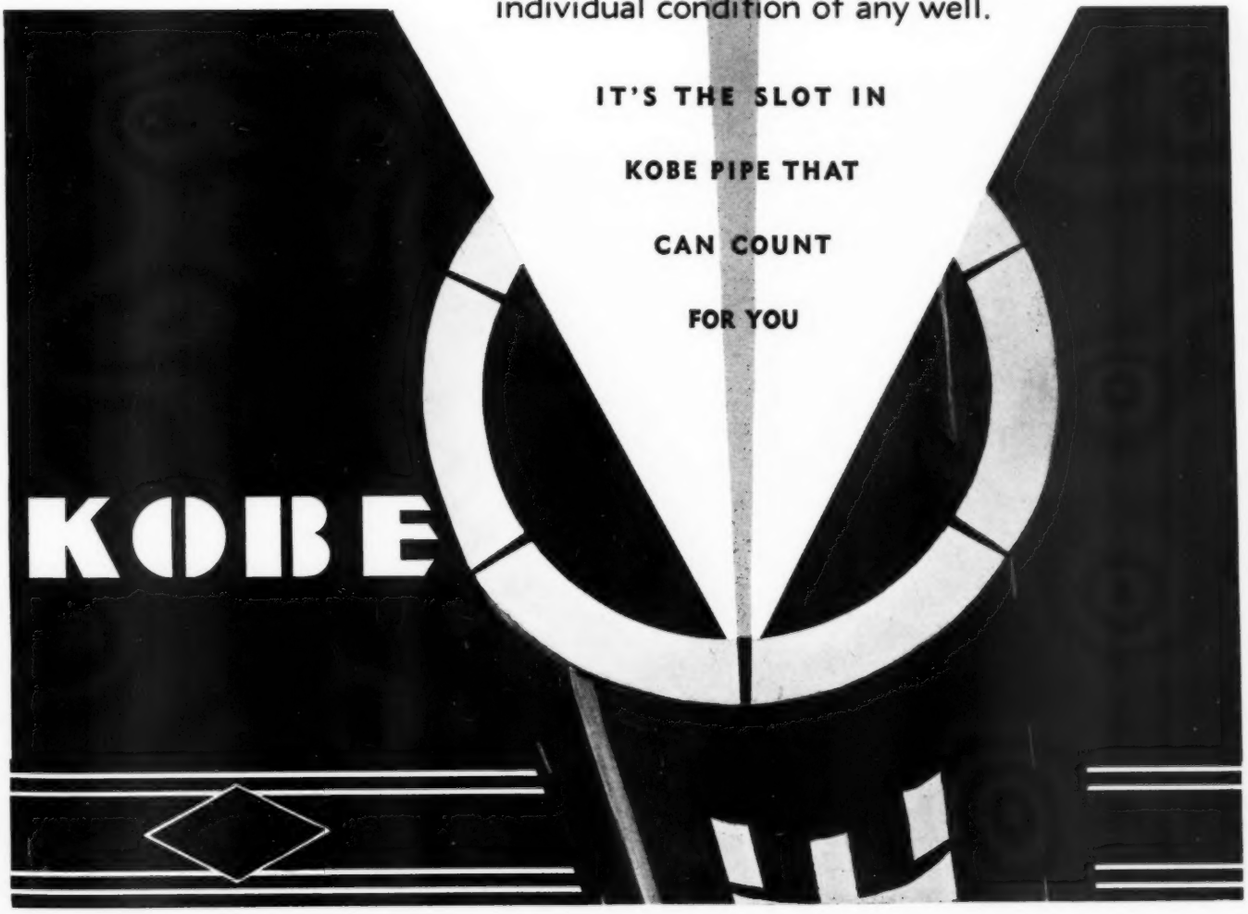

Engineering Fundamentals Department

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W. L. NELSON
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Editors

Elements of Applied Petroleum Production

By K. C. SCLATER

Article 28

INCREASING ULTIMATE YIELD OF OIL—(Continued)

WATER-FLOODING—(Continued)

When we speak of modern water-flooding practice we refer chiefly to controlled artificial water-flooding methods rather than to what are known as natural floods.

In a natural flood the water drive derives its power only from the hydrostatic pressure of water from a natural source —usually from water strata overlying the oil sand. The regulation of water input is largely fortuitous. A water drive of this kind is restricted in its application and cannot be closely controlled, except possibly by maintaining back-pressure on the oil wells.

In the controlled artificial flood, on the other hand, the water is injected under pressure from the surface and the quantity, pressure, and purity regulated to subsurface needs.

Of all the water floods that have been used, the five-spot delayed drilling system offers the greatest possibilities for high ultimate recovery. The water-intake wells are drilled first and water injected under high pressure into the oil sand. Not until the pressure in the sand has been built up to a certain predetermined point are the oil wells drilled. This process reduces the tendency of the water to bypass the less permeable streaks of oil sand. The delayed flood results also in a high initial well production and gives a rapid return on the investment.

A measure of the efficiency of the water-flood is the ratio of oil recovered to that in the sand when the flood was begun. On this basis the relative efficiencies of the various flooding system are as follows:[113]

Staggered line drive	80.0 percent
Five-spot	72.3 percent
Regular line drive	70.6 percent
Seven-spot	74.0 percent

Although these efficiencies were obtained by laboratory experiment, they were found to check remarkably close with the results of actual flooding operations in the Bradford field. On certain leases under observation in that field the regular five-spot system had an efficiency of 74 percent and the seven-spot system an efficiency of 79 percent.

Water-flooding is vastly superior to other production methods for increasing the recovery of oil. Estimated recoveries in old shallow fields of the stripper class obtainable by three different methods of production are compared in the following table:[114]

Method	*Time*	*Yield*
Pumping	25 years	1500 bbl.
Repressuring	10 years	2000 bbl.
Water-flooding	2 years	3000 bbl.

CORING AND CORE ANALYSES. Core analyses supply the vital information upon which the feasibility of water-flooding an oil sand is determined; hence care must be exercised in coring to keep the core from contamination. It is important to guard against water-washing of the core to prevent undue drainage of oil from the core from the time it is cut until it is brought to the surface.

A valuable aid in this connection is the cable tool core barrel, which is widely used in water-flooding development operations, because in coring with it high water pressure is not necessary and the core can be recovered at the surface within a very short time after it is cut.

Rapid, precise methods of core examination have been developed[115, 116] the results from which when properly interpreted give an accurate picture of sand conditions. This information is supplemented where possible by reliable production records.

WELL-SPACING. Well-spacing in an artificial water-flood is dependent entirely upon the sand resistance and the pressure required to overcome this resistance.[117] Spacing should be such that a reasonable water injection pressure can be used. If the spacing is too wide for the pressures used poor recoveries will result. In planning a well-spacing program and the layout of water-intake wells the important relationship between well-spacing and water pressure must be kept in mind.

All wells should be drilled vertical so that the spacing in the oil sand shall be the same as at the surface. In a modern water-flood project now under development in Oklahoma[118] the wells are 330 ft. apart. The lease is 80 acres in extent and has 45 water intake wells. A five-spot delayed drilling plan is being followed and each oil well when drilled will be in the center of a 2½-acre tract. The oil sand (Bartlesville sand) is 40-50 ft. thick and lies at a depth of 500 feet.

WATER-INTAKE WELLS. Water-intake wells are each equipped with a water meter and pressure gauge for close control of the water input. Accurate records of the daily input of water and the pressure will enable the man in charge to detect any irregularity such as might result from plugging of the sand or other cause.

In the water-flooding project recently begun in Northern Oklahoma[118] the individual water supply line to the water-intake wells is 1½-in. and is reduced to ½ in. at the well, where high-pressure brass fittings and a water meter are inserted, and the line then swaged to the well casing. Dissolved gases in the water make it corrosive, and to eliminate trouble from this source all water-intake wells are cased with cement-lined pipe.

WATER SUPPLY. Success in modern water-flooding operations is dependent on an adequate water supply. Quality of water probably is less important than quantity. In the past the lack of an adequate water supply has starved many water-floods and made operations unprofitable.

It has been estimated that in old shallow stripper fields in the Mid-Continent from 25,000 to 75,000 bbl. of water per acre will be required for a water-flood over a four-year or five-year period.[114] On a 40-acre lease the water requirements might therefore reach a total of 3,000,000 bbl. or 1,000 bbl. a day for the whole property.

WATER TREATMENT. Water should be free from corrosiveness and from any impurities that will result in clogging the sand pores. Clogging of the pores will result in high injection pressures and seriously impair the efficiency of the water drive.

Water used for flooding the Bradford field requires treatment before use. Iron compounds are in solution in the raw water, and when the water is exposed to the air the iron compounds are oxidized and form jelly-like solids that are carried in suspension in the water. To remove these and other solids in suspension the water is agitated with air, treated with lump alum as a coagulant, and passed through one or more rapid sand filters.

A supply of water that is pure enough to use without treatment is rarely to be found in the vicinity of an oil field. Soluble iron and other mineral salts are generally present and chemical treatment and filtering will usually be necessary. Analyses[114] of several Mid-Continent subsurface waters show the total solids to vary from 189 to 128,131 parts per million and the *pH* values from 6.5 to 7.3. Some of these waters contain dissolved carbon dioxide and hydrogen sulphide, gases that render a water corrosive.

What constitutes thorough planning in the handling and treatment of water is exemplified in the Oklahoma water-flooding project now under development,[118] where the water supply, obtained from sands 1500 ft. deep, or 1000 ft. below the oil sand, is high in salts and is corrosive.

Water is supplied to the wells from central water-pumping plants from which distribution mains or trunk lines are laid to convenient points on the property. On the 80-acre lease under modern water-flooding development just mentioned[118] a 5-in. line is employed as a distribution main from which a 1½-in. line runs to each water-intake well. All water distribution lines and the casing of water-intake wells on this project are cement-lined to eliminate trouble from corrosion.

INJECTION PRESSURES. The injection pressure is a function of the distance between the water-intake well and the oil well. For example, a water-flood in the Bartlesville sand, Oklahoma, lying at a depth of approximately 500 ft. and with a spacing of 400 ft. between like wells, requires a pressure of 450 lb. per sq. in. to inject from 35 to 70 bbl. water/day/well, the quantity injected depending on the thickness and permeability of the sand.[114]

Pressure resistances per lateral ft. in the Bradford sand are given by Nowels.[117] On nine leases observed the pressure resistances ranged from 4.33 to 10.9 lb. per lateral foot; these were calculated by dividing the pressure at the face of the sand by the distance between the water-intake well and the oil well. The average input per well for this critical pressure on all properties of the Forest Oil Corporation in the Bradford field was 28 bbl. water daily, and for this intake the pressure drop was from four to nine lb. per lateral foot. The injection pressures on wells observed were from 452 to 781 lb. per sq. inch. Nowels has taken a formula for radial flow of "dead" fluids developed by engineers of the Gulf Oil Corporation and expressed it in convenient terms for use in the calculation of water-flood pressures.
It is:

$$Pd = \frac{Q \times \log_e \frac{Rd}{Rw}}{k \times t \times 7.08}$$

where Q = volume of fluid intake in bbl./day
k = permeability factor (cc./sec./cm.²/atm. pressure/cm.)
t = sand thickness in ft.
Pd = pressure drop across drainage radius from well in lb./sq. in.
Rd = drainage radius from well in ft.
Rw = radius of well bore in ft.

Nowels also uses the following formula for the distance between oil and water wells:

$$D = \frac{P_1 + P_2 - P_b}{f + 1.6}$$

where D = distance in ft. between water-intake well and oil well
P_1 = pump pressure available at head of intake well, in lb./sq. in.
P_2 = hydrostatic pressure on sand in water-intake well in lb./sq. in.
P_b = any back-pressure that might exist on sand in oil well in lb./sq. in.
f = frictional resistance per lateral ft. offered by sand in lb./sq. in.

In terms of P_1 the pressure available for use at top of the water-intake well should be:

$$P_1 = (D \times f \times 1.6) - P_2 + P_b$$

where the terms are the same as in the preceding formula.

QUESTIONS

1. What is meant by a delayed water-flooding system?
2. What are the advantages of a delayed water-flooding system?
3. Under what conditions is the five-spot delayed water-flood particularly applicable?
4. Why is it important to check the quality of the water to be used in water-flooding operations?
5. How would plugging of the pores of the sand be detected in water-flooding operations?
6. How is injection pressure related to well-spacing?

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Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XXVIII

METALS FOR HIGH TEMPERATURES AND PRESSURES

ALTHOUGH the study of special steels and alloys is a confusing subject to most plant men, it is deserving of close attention. The truly great development of modern cracking systems and high-pressure boilers, as well as many other achievements in the refinery, may be directly traced to the manufacture of special steels and alloys to withstand high temperatures, high pressures, and severe stresses. In fact, the realm of possibility widens with each metallurgical advancement and many new processes could be put in operation today, were suitable construction material at hand. Among the notable materials that have been influential in these developments are: alloy-steel studs and bolts, forged and cast-alloy-steel valves and fittings for high pressures and temperatures, heavy seamless steel tubes, particularly those composed of a high percentage of alloy element, special welded vessels, metal to metal high-pressure flanges, large alloy-steel vessels, high-pressure high-temperature pumps, and corrosion resistant materials for all the above services; however, another factor, namely, the cost, is of prime importance. Many suitable materials can be suggested but they are far too expensive to permit commercial installation. Thus, cast iron, cast steel, and the brasses are still used for most construction work even though more suitable materials are available. Frequently the decision regarding the installation of an expensive material rests with the permanency of the installation and the finances of the company.

The particular properties that materials for a high temperature and high pressure must exhibit, may be classified as:

1. Resistance to high-temperature oxidation. The rate of rusting, scaling, or oxidation, is far greater at elevated temperatures than at room temperature.

2. Resistance to high-temperature corrosion. Corrosion may be due to any of the agents mentioned previously but the corrosion action is more violent at elevated temperatures.

3. Ability to retain strength at elevated temperatures. In contrast to low-temperature properties, steels gradually deform or stretch if they are held at a high temperature for a long time.

These three properties are usually encountered at the same time but fortunately the steels that are resistant to oxidation and corrosion usually retain their strength at elevated temperatures. Steels having these properties usually present difficulties in fabrication and hence it is usually necessary to sacrifice the above properties to some extent when fabricating large forged vessels. Thus, forged or cast valves and fittings, and tubing, can be manufactured from almost any of the alloys that are suitable in the above respects, but large pieces in which the ductility of the material is of prime importance, such as reaction chambers, high-pressure fractionators, pressure vessels, etc., must be constructed of low-percentage alloy steels that can be more easily fabricated.

HIGH-TEMPERATURE OXIDATION

Among the parts of equipment that suffer most by oxidation are pipestill tubes, tube supports, structural steel exposed to furnace temperatures, firebox steel, and the bottoms of externally-fired vessels such as shellstills or cokestills. All the above services have been successfully met by the use of alloy steels except that alloy shells have not as yet been widely used. High percentages of the special alloy element are required to withstand high-temperature oxidation and the fabrication of these steels is so difficult that large vessels cannot be built cheaply.

Although the above uses do not consume a large amount of steel, they are very important because ordinary steel or cast iron rusts or scales so rapidly at furnace conditions that the replacement of the exposed steel parts becomes very expensive. As an indication of the relative oxidation resistance of various materials, consider Table 41. In the table the rusting of the first steel was taken as unity and the other steels rusted much more, as indicated in the table.

Thus, ordinary steel oxidized or scaled about 256 times as fast as the 18-8 chrome-nickel steel containing four percent of tungsten. Steel No. 2 is widely used for tube supports and header plates in stills and although it is not so good as steel No. 1, it is far cheaper; however, high chrome steels are expensive—they cost about ten times as much as steel and 50 times as much as cast iron. Table 41 shows the beneficial effect of chromium and although no silicon steels are shown in the table, a small amount of silicon (up to four percent) is also beneficial.

The superior properties of the chromium and chrome-nickel steels are also evident in Fig. 56. This figure is more valuable

TABLE 41
Atmospheric Oxidation at 1650 deg. fahrenheit

No.	Material	Relative Amount of Scaling using steel No. 1 as a basis
1.	17.7 Chromium, 7 Nickel, 4.2 Tungsten Steel	1
2.	18 Chromium, 8 Nickel Steel	5
3.	Pure Nickel	37
4.	3.25 Nickel Steel	193
5.	Ordinary Carbon Steel	256
6.	Pure Iron	340

* Professor of Petroleum Refining, University of Tulsa.

Electrically Powered drilling equipment

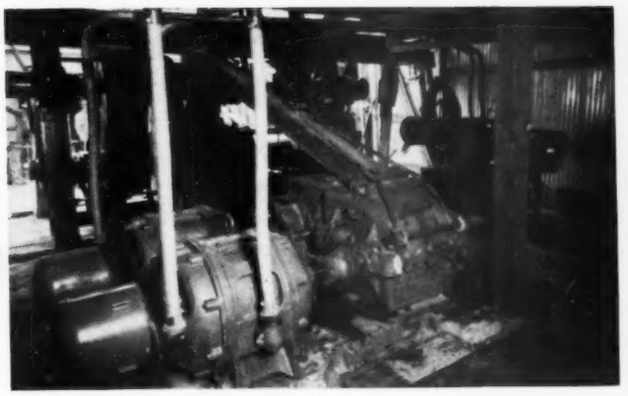

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TABLE 42

Analyses of Steels Shown in Fig. 56*

S.A.E. 1020	0.2 carbon steel
4-6 Chrome	4- 6 percent chromium
Enduro-F.C.	12-15 percent chromium
Enduro-S	
Enduro-18-8	18 chromium, 8 nickel
Enduro-18-8 Mo.	20 chromium, 9 nickel, 3 molybdenum
Enduro-AA	16-18 chromium
Enduro-20-23 Chrome	20-23 chromium
Enduro 18-18B	18 chromium, 8 nickel, 2.5 silicon
Enduro-HC	25-30 chromium
Enduro-HCN	25 chromium, 12 nickel
Enduro-NC3	25 chromium, 20 nickel

* Courtesy Republic Steel Co.

TABLE 43

Firebox and Still Castings*

	Temp. deg. fahr.	*Total Carbon*	*Silicon*	*Nickel*	*Chrom.*	*Type*
A	up to 600	3.1-3.4	1.2-1.75	.....	.....	Plain
B	600- 900	3.1-3.4	1.2-1.75	2.0	0.75	Cu. Ni-Cr.
C	900-1300	2.6-3.1	1.5	14.5	3.5	Nickel Resisting
D	1300-1800	Under 0.35	.....	10-12	24-28	Heat-Resisting Steel
E	1800-2000	Under 0.35	.....	35	15	Heat-Resisting Steel

* Tube supports, firebox castings, dampers, stack rings, etc. Alloys D and E are used interchangeably depending on the composition of the flue gas, particularly the S, in the furnace.

than Table 41 because it covers the entire temperature range, even to 2,200 deg. fahrenheit. The analyses of the steels shown in Fig. 56 are shown in Table 42.

The plain high chromium steels (without nickel) are excellent resisters to oxidation but they become brittle when held at a high temperature. Nickel, and to some extent molybdenum, tend to stabilize the alloys so that the carbides do not migrate to the boundaries of the grains of metal and cause weakness. Even the chrome-nickel steels may give the same difficulty if they are not properly heat-treated. When 18-8 chrome-nickel steels were first used, several serious accidents occurred because of tube failures due to brittleness, but these inadequacies now have been corrected.

Table 43 indicates the materials that may be used for different temperatures.[1]

Inasmuch as the chrome steels are expensive, many refiners are using different steels in different parts of the furnace. Thus, for castings for supports, etc., steels D or E are used in the firebox or radiant section, and irons A, B, and C in the convection section depending on the temperature.

Likewise for tubes, 18-8 chrome-nickel may be used in most of the radiant section and in the first rows of the convection section, and 4-6 chrome steel and plain carbon steel in the convection section. A competent stillman can easily select those tubes that receive the most heat by a visual inspection of the furnace.

CREEP STRENGTH

The fact that steel tends to deform or stretch if it is exposed at a high temperature for a long length of time is of vital importance in the design of pipestill and boiler tubes. The ordinary short-time tests for determining the tensile strength of steel is not satisfactory because the strengths are far too high. For this reason, another type of test has been developed that is termed the creep strength. In this test the steel is held under temperature and pressure conditions that simulate plant conditions, and for a length of time that is as long as the expected service. The creep strength may be defined as the strength expressed in lb. per sq. in. that the material will withstand for an arbitrary length of time (say 10,000 or 100,000 hours) at a given temperature without deforming more than a given amount (usually one percent). Thus, the test is not so well defined as the common tensile strength tests but it is expected to give much more detailed information than the ordinary test, and hence it must be more flexible. The definition can be more easily understood by reference to Table 44. This table shows the relation between strength, deformation, and number of hours of heating.

Fig. 57 shows commonly accepted values of the creep strength. The alloys shown are the most widely used. The strengths are for an elongation not exceeding one percent in 100,000 hours (about 12 years). This length of time is thought to be amply long for any installation. Note that common carbon steel has very little strength at a temperature of 1,000 deg. fahrenheit.

In the past there has been some confusion concerning creep strength because the data of various experimentors were not entirely consistent. White, Clark, and Wilson[2] have explained these discrepancies to a large extent by a study of the treat-

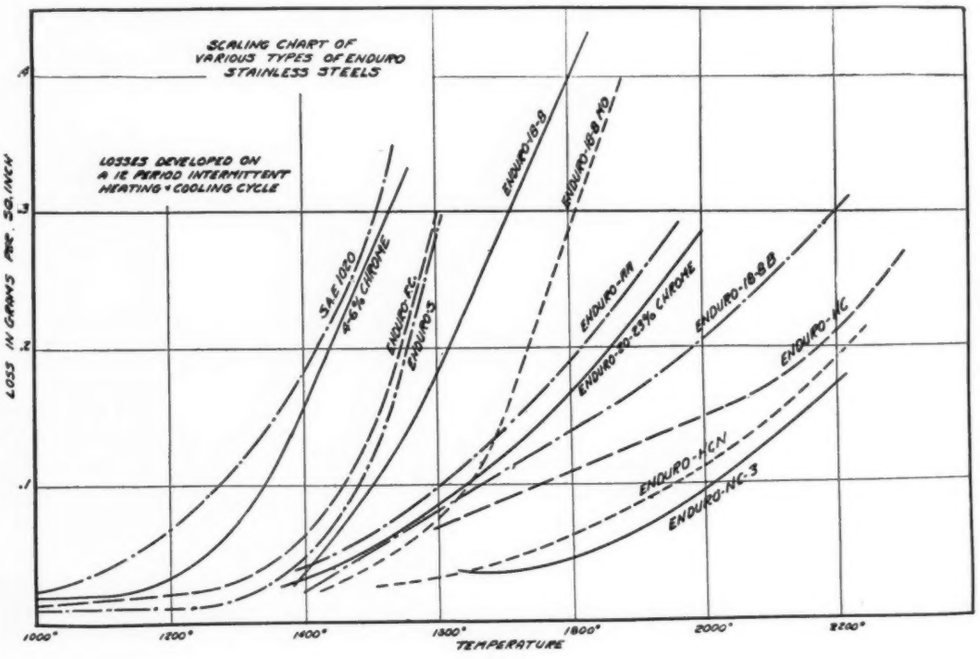

Fig. 56. Scaling chart of chromium and chrome-nickel steels

TABLE 44

Creep-Strength of Coarse-Grained and Fine-Grained Carbon-Molybdenum Steels

Inherent Grain Size	*Temp. deg. fahr.*	*1% in 100,000 hrs.*	*1% in 10,000 hrs.*	*1% in 1,000 hrs.*
Coarse	800	15,500	26,000	44,500
Fine	800	21,500	27,000	34,000
Coarse	1000	10,700	17,800	29,200
Fine	1000	9,600	15,800	26,000
Coarse	1200	480	2,000	4,050
Fine	1200	260	1,400	3,400

TABLE 45

Materials for Valves, Fittings, Bolts, Etc.

Use	*Nickel*	*Chromium*	*Vanadium*	*Manganese*
1. Bolts, Nuts	3.5	.....	.....	.....
2. Bolts, Nuts	1.5	.6	.....	.....
3. Bolts, Nuts	3.5	.75	.....	.....
4. Bolts, Nuts	.....	1-1.5	.15-.2	.75
5. Bolts, Nuts	.....	.....	.....	1.25
6. Valves and Fittings	1.5	.5	.....	.....
7. Valves and Fittings	.....	1-1.5	.15-.25	.....
8. Valves and Fittings	.....	4-6	.....	..... *
9. Valves and Fittings	18	8	.....	.....

* Also with .5 Mo. or 1W.

ments that the steel has undergone during manufacture. Among the factors investigated were composition, method of manufacture, heat treatment, grain size, cold working, and the test procedure. Space is not available to discuss these several factors, but one of them, the effect of grain size, will be illustrated by means of Table 44, which is reproduced from White, Clark, and Wilson.[2]

Thus, the coarse-grain steel excels in the higher temperature ranges and the fine-grain steel excels at 800 deg. fahrenheit. This is an indication of the sensitivity of the creep-strength measurements and an indication of the reason for the discrepancies that have been encountered.

LOW-PERCENTAGE ALLOY STEELS

The conditions that have been discussed heretofore were particularly severe ones and they justify rather expensive materials such as the high-percentage alloy steels that were discussed; however, a large volume of steel is used for less severe conditions such as those encountered by valves and fittings. In these the pressure may be very great but the temperature seldom exceeds 800 deg. fahrenheit. For such a service alloy steels are useful but it has been found that a relatively low percentage of alloying element is satisfactory. As an example, the compositions of alloy steels used for high-pressure and high-temperature valves and fittings and for stud bolts and nuts are somewhat as shown in Table 45.

In the case of large high-pressure high-temperature vessels such as reaction chambers, fractionating towers, evaporators, etc., the steel cannot be high in special elements because of difficulties with forging, etc. For this reason the amounts of alloy elements used are about as follows:

1. Nickel 4, Chromium .75
2. Chromium 1-1.5, Vanadium .15-.2
3. Chromium 1.5-2.25, Vanadium .2-.3

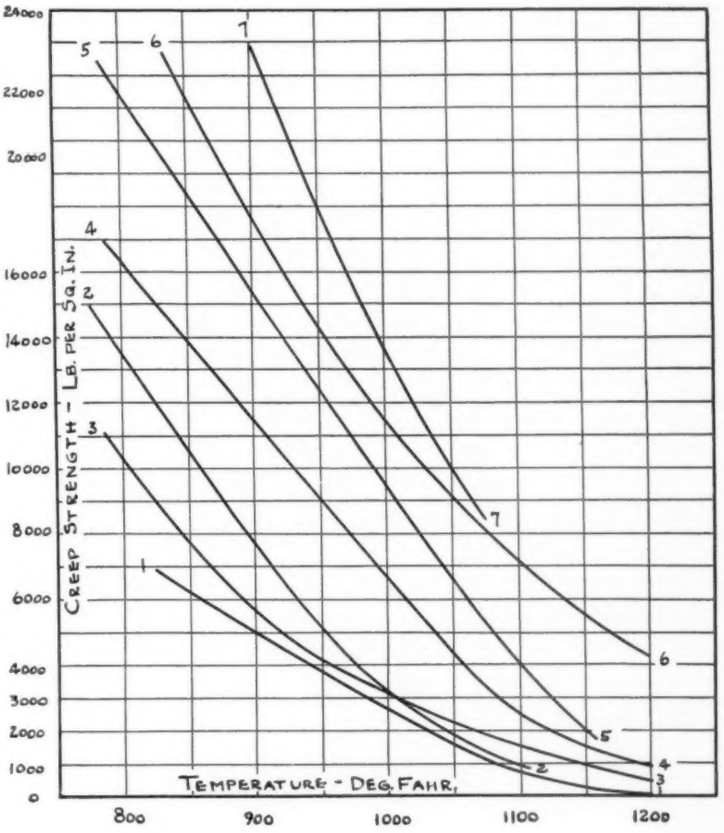

Fig. 57. Creep-strength of various types of alloy steels

Curve No.	*Kind of Steel*
1	0.08 carbon
2	0.2 carbon
3	4-6 chromium
4	4-6 chromium, 0.5 molybdenum
5	0.5 molybdenum
6	18-8 chrome nickel
7	1.4 chrome, 1 tungsten, 0.25 vanadium

QUESTIONS

1. What are the two most useful elements in producing a resistance to high-temperature oxidation?
2. Why is nickel so frequently used with chromium?
3. List several steels that retain their strength at an elevated temperature?
4. Which steel is the least expensive of the creep-strength steels?
5. Define "Creep-strength"?

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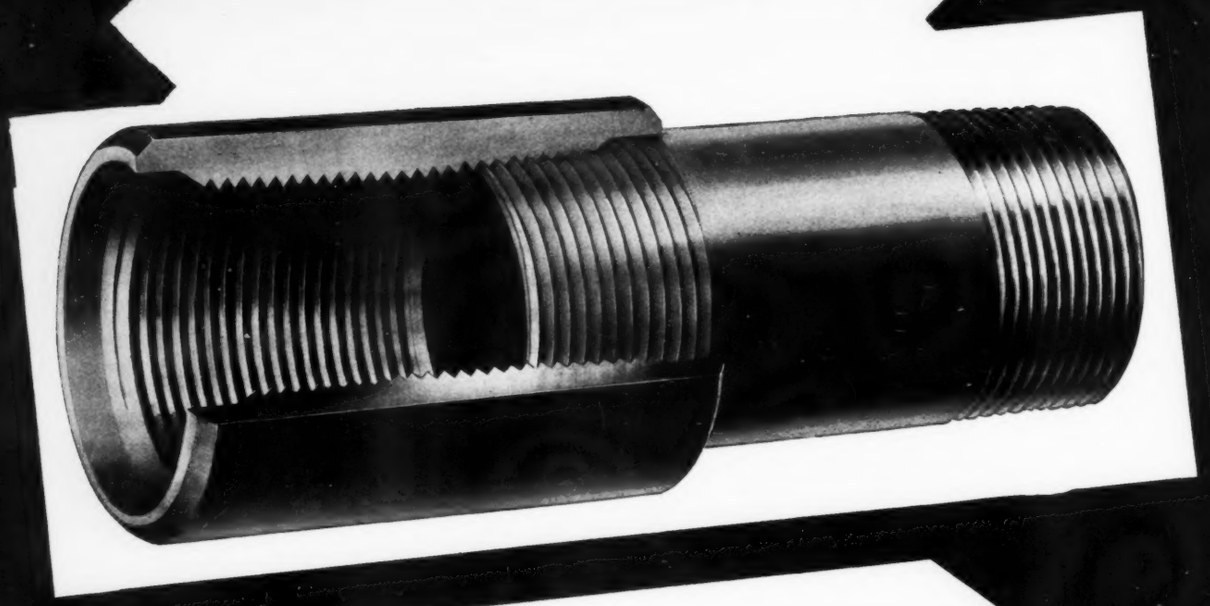

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Elements of Applied Petroleum Pipe Line Transportation

By C. E. MAIN, SR.
Engineer, Sinclair-Prairie Pipe Line Company

Article 19

FLOW OF LIQUIDS IN PIPE LINES (Part VIII)

Discharges at Other Pressures and Viscosities

In the demonstration thus far computations have been made for the oil at its minimum temperature in the winter time. The discharge for the maximum summer temperature at the maximum pumping pressure also is of interest. Two methods may be employed in computing the new discharge. Equation 19 (p. 93, September issue) will be found useful when there is a change in both the effective head and the viscosity; however, Equation 22a is convenient if the value of the first term on the right of the equality sign is known for the station district.

From an inspection of the discharge Equation 22 it can be seen that this equation can be re-arranged as:

$$B = \sqrt[n]{\frac{2g\,N^n\,D^s}{A\,b\,M}} \times \sqrt[n]{\frac{h}{k^w}} \quad . \quad . \quad . \quad (22a)$$

so that the value of the first term on the right of the equality sign may be computed for the station district, since these factors remain constant for all discharges, effective heads, and viscosities.

When the above values are substituted in this term we obtain 136.09 as a constant or multiplier for this particular station district.

$$\sqrt[1.75]{\frac{64.32 \times 1^{1.75} \times 12^{4.75}}{13186 \times 0.018168 \times 6.61942}} = 136.09$$

$$\log \text{ of } 136.09 = 2.1338377$$

Equation 22a may now be written as:

$$B = E \sqrt[n]{\frac{h}{k^w}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22b)$$

which must be known as a station district formula, since E must be computed separately for each station district.

To compute the summer discharge for a line temperature of 80 deg. fahr., the new observed gravity and viscosity at this temperature must be determined. An inspection of the Vanderveer temperature-gravity chart, or the A.P.I. gravity tables in the Tag Manual, will give for an observed gravity of 38.0 deg. (A.P.I.) at 35 deg. fahr., 41.6 deg. (A.P.I.) at 80 deg. fahr.; and from the temperature-viscosity curve of this particular oil we find that the viscosity at 80 deg. fahr. is 40 SUS, equivalent to 8.64 kinematic viscosity in centipoises when computed by Equation 7.

The new values of the effective head for 650 lb. pressure for an oil of 41.6 deg. (A.P.I.) observed gravity, computed as previously explained, result in 1696 ft. head, an increase of two and one-third percent.

We now have for the summer discharge:

$$B = 13609 \sqrt[1.75]{\frac{1692.8}{8.64^{0.25}}} = 6997.9 \text{ bbl./hr.},$$

and the increase in terms of bbl. per 24-hour day amounts to 21,352 bbl. or 13.78 percent, of which 1973 bbl., or one and one-third percent, was due entirely to the increase in the effective head caused by the change in the observed gravity of the oil.

Required Length of a Loop for a Given Increase in Discharge

It has been mentioned previously that the efficiency of a system of parallel lines depends entirely upon which section receives the additional pipe when it is desired to increase the carrying capacity of a district by laying additional pipe in one of the sections.

When a pumping district has two or more equally spaced gate plants, any desired increase in discharge of the district usually can be obtained by laying either an 8-in., 10-in., or 12-in. diameter loop in the proper section of the station district without putting in an additional gate plant; however, for the purpose of illustrating the method of computing the required amount of pipe to lay for a given increase in discharge, when the required length of the pipe to be laid is less than the length of the section in which the additional pipe is to be laid, let us assume a small increase in the discharge from 6150 to 6345 bbl. per hour for the same station district that was diagramatically shown in Fig. 5. From what has been explained previously it is obvious that the proper location of any additional pipe is in Section 1, if the efficiency of all the pipe in the district is to be improved.

On the question of the proper location of the new loop within a section, based entirely upon its carrying capacity, it is immaterial whether it starts at station A, ends at the gate plant, or starts and ends at some intermediate points within the section, provided, of course, a by-pass of sufficient size is installed at each end and is connected to all the other lines.

Fig. 6, which is Fig. 5 modified to show the new loop ending at the gate plant and beginning somewhere between Station A and the gate plant, the length of which is the purpose of the following explanation of the application of the formulae involved.

The several computations for the same observed gravity and viscosity at 35 deg. fahr. line temperature, using the new value of the discharge B of 6345 bbl. per hr. will be considered in their order.

The first step is to compute the required new friction head in both sections 2 and 3, from which the elevations of the

hydraulic gradient is determined at the gate plants, particularly the gate plant at the beginning of Section 2.

Second, compute the head in ft. of the liquid being pumped for the maximum pumping pressure at Station A from which the elevation of the hydraulic gradient is determined for the beginning of the district.

Third, the slope of the hydraulic gradient in ft. per actual mile for each part of the divided Section 1, will be computed to use with the total friction head determined from the difference in the hydraulic gradient at Station A, and at the end of the divided Section 1, in order to obtain the lengths of the two parts of the divided section.

For parallel line flow computations Equation 5 (p. 78, August issue) will be repeated here since this adaptation of the Hagen formula will be used for a transpostion to solve for the slope of the hydraulic gradient:

$$h = \frac{A b\, k^w\, B^n\, M}{2g\, D^s\, N^n} \quad \ldots\ldots\ldots \quad (5)$$

and for the slope of the hydraulic gradient in ft. per actual mile:

$$S = \frac{h}{M} = \frac{A b\, k^w\, B^n}{2g\, D_0^s\, N_0^n} \quad \ldots\ldots \quad (23)$$

when N_0 is taken as the equivalent number of lines in the section of D_0 diameter.

An inspection of Equation 23 will show that B^n/N^n is the equivalent discharge for one 12-in. line if D_0 equals 12, and if N_0 is the equivalent number of 12-in. lines in the section.

The slope S is the hydraulic grade in ft. per actual mile for one 12-in. line having an equivalent discharge of B^n/N^n bbl. per hour.

It must be remembered that if M_0 is taken as the equivalent length in miles, then N is always taken as one line of the chosen diameter D_0 upon which the equivalent M_0 was based. This applies when the computation is made for either the section or the entire station district.

When M is taken as the actual length in miles, then N is either the actual number of lines of D diameter or the equivalent number of lines of the chosen diameter D_0.

The relation of the factors, M, N, and D at first may be somewhat confusing until a little familiarity is attained in both the derivation and the use of the various transpositions of the original Hagen formula.

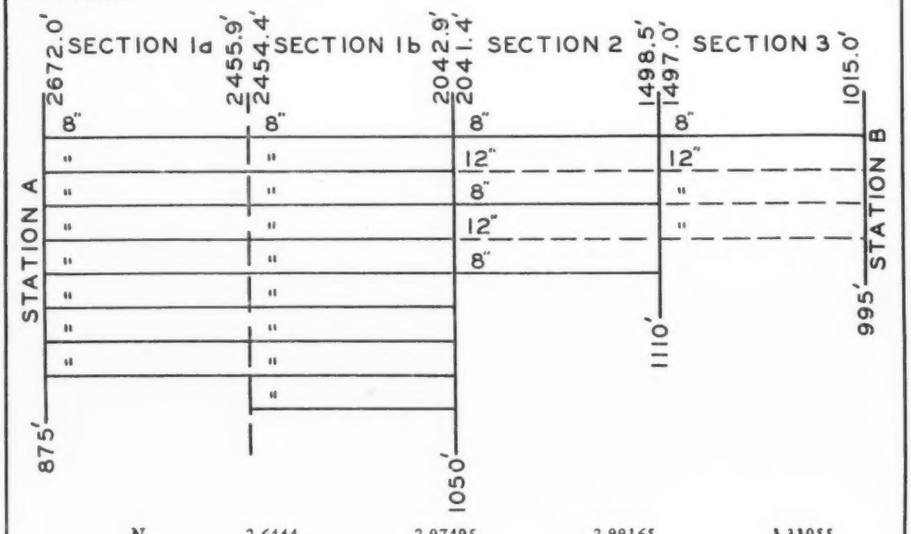
Another transposition of Equation 5 may be written:

$$M_0 = \left(\frac{2g\, D_0^s\, N^n}{A\, b}\right) \times \frac{h}{k^w\, B^n} \quad \ldots\ldots \quad (24)$$

from which the equivalent length M_0 of the district may be computed, when N is taken as one line of D_0 diameter.

Equation 24 is used only when it is desired to compare existing station districts for a new discharge or effective head, or both, by computing the required values of the equivalent miles M_0 in order to re-balance each station district. If the effective head of each district was the same for a given pump pressure, all stations would stay in balance regardless of the pumping pressures.

Pump pressure=650 lb. Pump head=1797 ft. Available friction head=1652.5 ft. Viscosity=98.5 SUS. k=19.44. Observed gravity=38.0 deg. A.P.I. at 35 deg. fahr. Equivalent Diameter D=12.00. B=6345. M=6.26245.



N	2.6444	2.97495	2.99165	3.33055
M	0.81897	1.55945	1.5643	1.3523
L	4.491	10.509	14.00	15.00
B/DKN			909.2	816.7
b	216.1	411.5	542.9	482.0

Fig. 6. Layout of system of parallel lines—same as shown in Fig. 5 but with addition of new loop in Section 1 beginning somewhere between Station A and the gate plant

For the new discharge, B=6345 bbl. per hr., the required friction heads for Sections 2 and 3 will now be determined by Equation 5 in which the equivalent length of each section will be used.

SECTION 2—

$$h_2 = \frac{13186 \times 0.018168 \times 19.44^{0.25} \times 6345^{1.75} \times 2.05724}{64.32 \times 12^{4.75} \times 1^{1.75}} = 542.9 \text{ ft.}$$

SECTION 3—

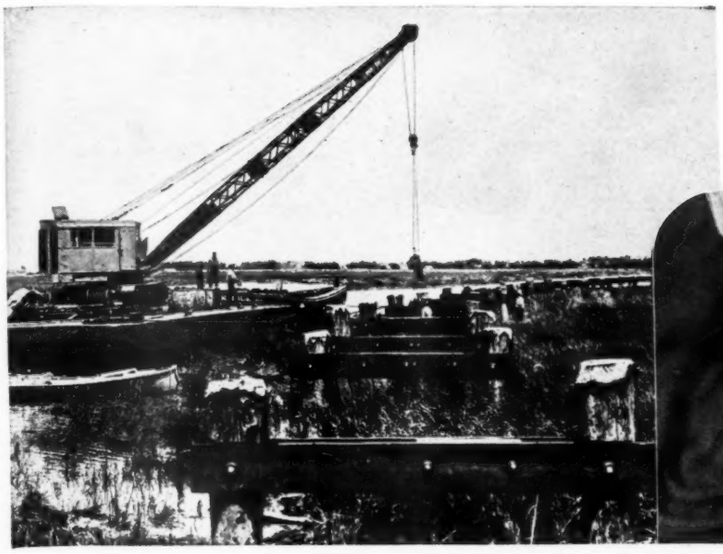
$$h_3 = \frac{13186 \times 0.018168 \times 19.44^{0.25} \times 6345^{1.75} \times 1.82679}{64.32 \times 12^{4.75} \times 1^{1.75}} = 482.0 \text{ ft.}$$

Both friction heads should be entered in their proper place in the acompanying sketch, Fig. 6.

Organization Changes Announced by Gulf

Since February 1st the producing, refining, and marketing operations of the Gulf companies have been conducted in Texas directly by the Gulf Corporation of Pennsylvania as an operating company. The pipe line operations are being conducted by the Gulf Refining Company, a Delaware corporation.

This is the result of a reorganization that will simplify the internal structure of the Gulf organization and give fewer operating units. Gulf Refining Company, Gulf Production Company, and Gulf Pipe Line Company will be discontinued. There will be no change in the personnel of the Gulf units, but company units heretofore operating as separate companies will be operated as divisions. The reorganization will result in no change in the amount of the capital or bonds or the financial structure of the Gulf Oil Corporation, it is announced.



Two 10-in., one 14-in., and one 6-in. lines were laid on this trestle. Insert shows close-up of Multi-Flame Lindeweld Head in action.

Pipe Lines that couldn't fail and didn't . . . *with Lindewelding**

OVER the wastes and swamps of the Deltas of the Mississippi River, pipe lines had to be laid for a sulphur plant. Failure was unthinkable! Once laid, these lines had to stand up . . . without leakage or troubles that would jeopardize operation of a costly investment. This was the exacting demand that had to be met . . . even though piling for the trestles to support the line would sink 30 feet of its own weight.

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Lindewelding was used to install two 12 in. water lines, one 6 in. oil line, and one 14 in. gas line over miles of trestle. In addition, eight miles of 6 in., 8 in. and 10 in. lines were installed in the sulphur field running from the plant to the wells and other points. After installation, these lines were tested under 200 lb. water pressure . . . *without a leak!*

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*Lindewelding is a new method of oxy-acetylene welding developed by the Linde engineering and research organizations. This method requires less oxygen, less acetylene and less welding rod. Welds can be completed in less time. Yet Lindewelding involves only a special flame adjustment and a "back-hand" technique, together with Oxweld No. 24 Lindeweld Process Welding Rod. When circumstances permit, the Multi-Flame Lindeweld Head can be used to increase further the speed of Lindewelding. This head costs $7.75. Lindewelding is consistently saving 15 to 40 per cent in welding time, rods and gases.

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FROM PRODUCTS OF UNITS OF UCC UNION CARBIDE AND CARBON CORPORATION LINDE UNION CARBIDE

ACCIDENTS HAPPEN IN OIL WELLS TOO!

FOR *Safety* FIRST AND *Successful* RESULTS

Always use **BAKER CEMENT EQUIPMENT**
for Guiding, Floating and cementing your Strings of casing.

You can be sure of

STRENGTH

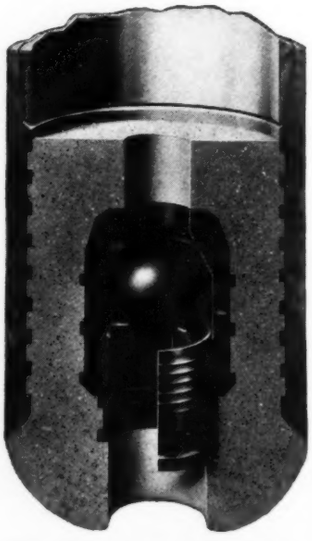
. . . beyond the collapsing strength of the casing

VALVE EFFICIENCY

. . . with areas large enough for free passage of cement, but small enough to preserve that important "wash-down" action. And a floating Bakelite ball which double-seals against live rubber (backed by Bakelite) to provide a leakproof back pressure valve the instant reverse pressure develops

DRILLABILITY

. . . with only concrete and the minimum amount of bakelite which drill out and circulate away. Bit expense is reduced—no time is lost—and you are soon ready for coring or for drilling *straight* ahead. No metal or other dangerous fragments can be left in the hole.



Look on Pages 169 to 180 of your 1936 Composite Catalog for details on the many types of this safe and successful line of equipment.

BAKER CEMENT EQUIPMENT

for guiding—floating—cementing casing

BAKER OIL TOOLS, INC.

POST OFFICE BOX 609 · HUNTINGTON PARK · CALIFORNIA

COALINGA • TAFT • HOUSTON • OKLAHOMA CITY • TULSA • NEW YORK

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

Frustration

"Whatcha so sad about?"

"Last night I dreamt that I was in a harem and the keeper asked me if I'd like to have a femme. I said, 'Yes,' so he was just about to go out and get me one when a brunette passed. But I said I wanted a blonde. Then he sent the brunette upstairs to get one for me. While we were standin' around waiting for the blonde I woke up, and I've been kickin' myself all day long for not havin' taken the brunette.—*Penn Punch Bowl.*

* * *

Young Man: Pardon me, this must be the wrong berth.

Old Maid (sighing): How you boys do jump at conclusions.

* * *

"There was a thief in my room last night and I thought it was my husband."

"Did he get anything?"

"Well, I didn't miss anything."

—*Hamilton Continental.*

* * *

Just a Wee Touch

"Yes, madam, what can I do for you today?"

"I'm going to be married next Tuesday and I would like to get some silk pajamas. What color is appropriate for a bride?"

"White is the preferred color if it is your first marriage, and lavender if you have been married before."

"Well, you'd better give me some white ones with just a wee touch of lavender in them."—*Rice Owl.*

* * *

He: If you had to and didn't want to, what would you do?

She: Give one away.

* * *

Wife (to late returning husband): Is that you John?

John: It'd better be.

* * *

Aroused Parent: Did I see you grab my daughter by the foot?

"Oh, no. Far from it."

* * *

The following note was received by a rural school teacher from the mother of one of her pupils:

"Dear Teacher—My John is getting all peeked and thin. He says he can't get no blood from his vittles from you always nagging at him about his manners. Now I want to tell you my kids don't need any teacher to learn them manners. If you had ever et at our house and knowed how refined pa is. you would be ashamed. I have lived with their pa for 20 years and never once have I seen that man put his knife in the butter without licking it first. I don't want to have to complain to you again."

* * *

A Gentle Hint

They had been sitting in the swing in the moonlight alone. No word broke the stillness for half an hour until "Suppose you had money," she said, "what would you do?"

He threw out his chest in all the glory of young manhood. "I'd travel." He felt her warm, young hand slide into his. When he looked up she had gone. In his hand was a nickel.

* * *

Eliza, the belle of Birmingham's darktown, on her wedding day received no gift from the bridegroom. But Mose, after the honeymoon, atoned for his negligence by bringing to his bride a wash-tub, a wash-board and a hand mirror. As Eliza eyed the strange medley of gifts, Mose said:

"Liza, you can hab yo' choice ob dese presents. Yo' can take dis tub and washbo'd an' go to wuk—or take de mirror, an' sit down in de corner an' watch yo'self starve!"

* * *

Call Your Shots

It seems that two boxers were fighting the main bout at a small club.

At the end of the first round, the kid who was taking a bad beating limped back to the corner and was ready to call it a night. His manager shouted, "Don't be a fool. He ain't laid a glove on you."

The same thing happened in the second round and the soft-hearted manager repeated his speech. "That's swell. See, I told you he ain't laying a glove on you."

In the third, the blows bounced off the poor kid's head like a ball around a roulette table, and he managed to stagger to his corner. He looked up at his manager and roared, "Don't tell me. I know. He ain't laid a glove on me. Well, watch the referee then, because somebody in that ring is giving me a hellova beating."—*Carnegie Tech Puppet.*

First Co-ed: You simply have to hand it to Alfred.

Second Ditto: Why?

First Co-ed: Oh, he's so shy and bashful.—*Cornell Widow.*

* * *

Nonchalance

Lids off to the lad out on the golf course who struck a new high in *sang froid* recently. He was teeing off at the first hole, and about three foursomes were waiting for him. At the first stroke which had a world of power behind it, he missed the ball completely. The waiting crowd shifted on its feet. Once more he missed the teed ball. This happened four times. The crowd was embarrassed but not so the chap with the club. With an engaging smile, he turned on them all. "Tough course," he remarked.

* * *

The young wife was in tears when she opened the door for her husband. "I've been insulted," she sobbed. "Your mother insulted me."

"My mother," he exclaimed. "Why, she is a hundred miles away."

"I know, but a letter came for you this morning, and I opened it."

He looked stern. "I see, but where does the insult come in?"

"In the postscript, it said: 'Dear Alice, don't forget to give this letter to George'."

* * *

Housewife (to tramp): I know you. You are one of the tramps that I gave a pie to last summer."

Tramp: You are right, madam. You gave it to three of us. I am the sole survivor.

* * *

Bill: I et six eggs for breakfast this morning.

Jerry: You mean ate, don't you?

Bill: Well, maybe it was eight I et.

* * *

Mother: Now remember while I'm away, dear, that if you pet and drink and smoke men will call you fast.

Daughter: Yes, just as fast as they can get to a telephone.

* * *

A young lady went into a drug store. "Have you any Lifebuoy?" she asked.

"Set the pace, lady," said the young drug clerk, "set the pace."

AL BAPTIE has been brought back from Holland by his company, the Shell Oil Company, and placed in charge of its exploitation department at Long Beach, California.

J. D. and **R. B. HAWK,** of Long Beach, California, have formed the Calcoast Oil Company. They have considerable acreage in Kern County.

TORREY WEBB, of The Texas Company, Los Angeles, California, was a recent visitor in Texas.

R. L. HUNTER, of the Anglo-Iranian Oil Company's staff in Iran, has retired following 15 years' service. He has been superintendent of production at various times of all the chief producing areas of the company, both in Iran and Iraq.

S. G. McFARLANE, a director of the Commonwealth Oil Refineries, Ltd., London, England, has resigned that post following his appointment as official secretary to the Australian High Commissioner's office in London.

PAUL WOOG, chief chemist of the Cie Francaise des Petroles, has been made a Chevalier of the Legion of Honor.

DR. JOHN GRISWOLD, resident chemist at the Pure Oil Company refinery at Muskogee, Oklahoma, has been transferred to the technical division of the company at Chicago. He has been succeeded by G. Frederick Eisele.

H. P. SANDERS has been transferred by the Pure Oil Company from the Marcus Hook, Pennsylvania, refinery to Cabin Creek, West Virginia, as resident chemist. He takes the place of **C. W. COOPER,** who is now at Smith's Bluff, Texas.

B. A. MYERS has been elected a director of the International Petroleum Company of Toronto, Canada. Formerly he was manager of the Tropical Oil Company.

ED J. KLOPFENSTEIN has been made division superintendent for the Seminole district by the Indian Territory Illuminating Oil Company, succeeding **B. O. HINDMAN,** resigned. He had been a petroleum engineer in the Oklahoma City district. **C. C. BRUNTON,** field engineer at Oklahoma City, was transferred to Seminole at the same time.

M. P. YOUKER, of the Phillips Petroleum Company, Bartlesville, Oklahoma, was injured in an airplane crash near Denton, Texas, on the night of January 29, in which the pilot was killed.

FRANK E. TWITCHL, drilling superintendent for Cia. Petrolera Lobitos of Peru, was a recent visitor in California.

HARRY B. HARTER has resigned as vice-president of the Panola Pipe Line Company to become East Texas representative for a Florida lumber concern.

JOHN L. O'SHAUGHNESSY has been made vice-president and general manager of the Lario Oil and Gas Company, with headquarters at Oklahoma City, Oklahoma. He is the son of **JOHN L. O'SHAUGHNESSY,** who is president of the Lario and also the Globe Oil Refining Company.

T. B. JONES, JR., is now an executive assistant to **C. H. LIEB,** president of the Carter Oil Company. His headquarters are in Tulsa, Oklahoma.

R. E. CLARK, petroleum engineer, Phillips Petroleum Company, has been transferred to Odessa, Texas, from Midland.

F. J. WELCH has been transferred from the Standard Oil Company to the Lago Petroleum Corporation and is now in Venezuela. Formerly he was stationed in Argentina.

F. B. KOONTZ, vice-president in charge of manufacturing for the Mid-Continent Petroleum Corporation of Tulsa, Oklahoma, is spending his vacation in Florida. He is accompanied by Mrs. Koontz.

JAMES B. O'BRIEN, assistant general manager of the Huasteca Petroleum Company at Tampico, Mexico, will leave the latter part of March to become assistant general manager of the Lago Petroleum Corporation in Maracaibo, Venezuela. He will be succeeded at Tampico by **J. B. BARNETT,** with whom he is changing positions.

GEORGE A. PETERKIN, vice-president of Williams Brothers, Inc., Tulsa, Oklahoma, recently moved to Houston, Texas, to manage the Apex Construction Company, a subsidiary of Williams Brothers, Inc.

REX K. DAVIS, production superintendent for the Standard Oil Company of Venezuela in the Cumarebo field, was recently married in this country while here on vacation.

H. L. JOHNSTON has been made superintendent of the Hobbs, New Mexico, district by the Continental Oil Company. He was farm boss. **HARRY MILLER,** district clerk, has been promoted to farm boss at Cooper and Jal, and **J. P. McCORMICK** succeeds him as district clerk, being transferred from Fort Worth, Texas.

N. M. DeWOODY, petroleum engineer, Stanolind Oil and Gas Company, has been transferred from Iraan to Midland, Texas, by his company. **H. T. HUNTER** has been sent to Hobbs, New Mexico, from Midland.

C. L. SWARTS, petroleum engineer with the Lago Petroleum Corporation of Venezuela, has been transferred to the staff of the Romana-Americana, S. A., and been made drilling superintendent for the latter organization.

LET'S LOOK AT ITS RECORD

Actual records, not claims, tell the story of the Parkersburg Long Stroke Pumping Unit. Here are some typical performance records.

- *Brea, California:* Produces 620 barrels of fluid daily from 5100 feet at less than 5% of the cost of gas-lift, which it replaced.
- *Oklahoma City Field:* Operating at 10—132″ strokes per minute, it is producing 475 barrels of oil daily from a depth of 6500 feet.
- *Mt. Pleasant, Michigan:* Increased oil production 63.6% and total fluid 47%. Decreased rod load 27.5% and number of rod reversals 55%. Operated for 133 days without a rod failure.
- *Texas:* Produced 936 barrels of oil from 2350 feet through 3″ tubing—an increase of 24% over previous production with conventional type pumping equipment.

Facts like these eliminate guesswork and definitely demonstrate the advantage of a long, slow pumping stroke. If your present equipment isn't doing as well or better it's time to investigate the Parkersburg Long Stroke Unit. Write today for the complete story.

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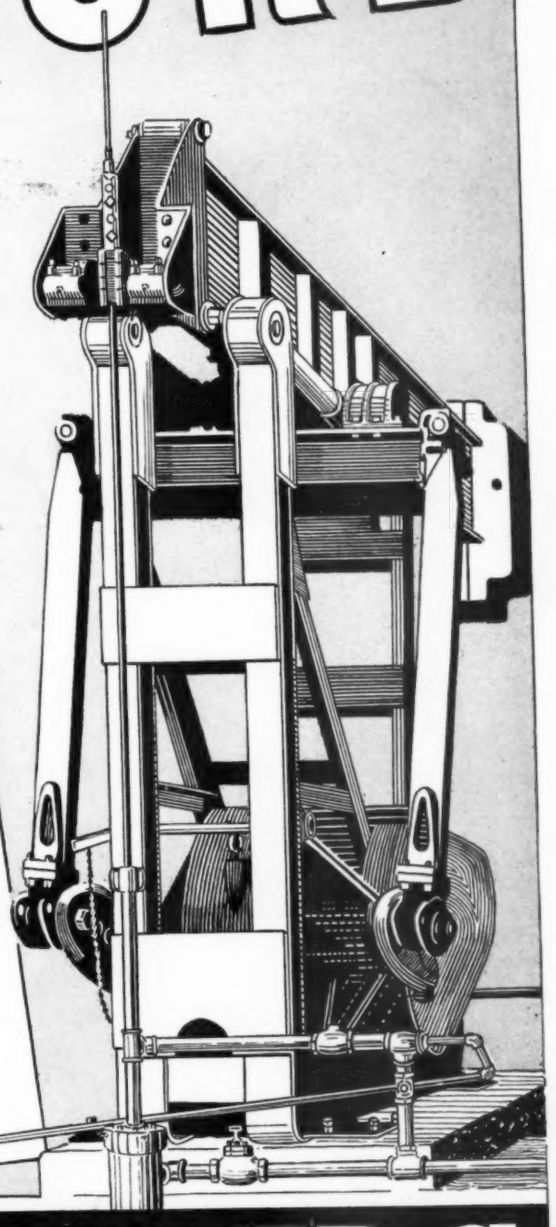


Quality and Service SINCE 1897

PARKERSBURG

Impressive List of Exhibitors for Houston Oil Show

New contracts are being signed daily for the seventh Oil Equipment and Engineering Exposition, to be held in Houston, Texas, April 20-25, inclusive. A large number of concerns who have not participated in the past will display their products this year, Ed Lenzner, manager of the Exposition, states. Many of the exhibitors are taking larger space than they had at the last year's Exposition and all available space in the Convention Building will be sold prior to the Exposition dates, according to the management.

Various new features will be added to make the Exposition of more value to the visitors, as well as the manufacturers exhibiting. The number of new patents and inventions will be greater than at any previous Exposition, it is stated. All inventors will be given free space to exhibit models of their new patents. This department will again be in charge of Lester Clark, patent attorney of Houston. Every endeavor will be made to assist inventors in placing the newest developments before the manufacturers. Several petroleum engineers will judge these exhibits and prizes will be awarded.

Prizes again will be given to the best exhibits of oil tools and the judging of the booths will be made by a group of oil men and engineers, headed by Chase E. Sutton, division manager, Pure Oil Company; Stanley Gill, consulting engineer, Houston; E. C. Lawry, assistant production manager, Shell Petroleum Corporation; Paul Hubbard, assistant superintendent of production, Gulf Refining Company; W. T. Doherty, assistant chief petroleum engineer, Humble Oil and Refining Company; Malory McDonald, president, Advertising Club, Houston; and several others.

Free admission tickets will be provided all oil men and their entire personnel or they may be obtained from the offices of *The Petroleum Engineer* magazine.

The following is the list of exhibitors to February 1. New space contracts are being signed daily, and the additional names of exhibitors will appear in *The Petroleum Engineer* in the March issue:

Abegg & Reinhold Co., Los Angeles; Abercrombie, J. S., Co., Houston; Abercrombie Pump Co., Houston; Ahlberg Bearing Co., Chicago; Air-Maze Corp., Cleveland; Allsteel Products Mfg. Co., Wichita; American Hammered Piston Ring Co., Division of Bartlett Hayward Co., Baltimore, Md.; Armstrong Bros. Tool Co., Chicago; Atlas Engineering Works, Houston; Ayres Engineering Company, Houston.

Baroid Sales Company, Los Angeles; Benjamin Electric Mfg. Co., Des Plaines, Ill.; Bettis Sales Company, Houston; Boiler Equipment Supply Co., Oklahoma City; Buck & Stoddard, Inc., Los Angeles; Buda Company, Harvey, Ill.; Bullard, E. D., Company, Houston; Burt Corp., Tulsa.

Cameron Iron Works, Houston; Caterpillar Tractor Co., Peoria, Ill.; Cavins Bailer Service, Long Beach, Calif.; Chiksan Oil Tool Company, Fullerton, Calif.; Clark, Lester B. (Patent Attorney), Houston; Coen Company, Inc., Los Angeles; Cooper, Fred E., Tulsa; Crouse-Hinds Company, Chicago; Crutcher-Rolfs-Cummings, Inc., Houston; Cummins Engine Company, Columbus, Ind.

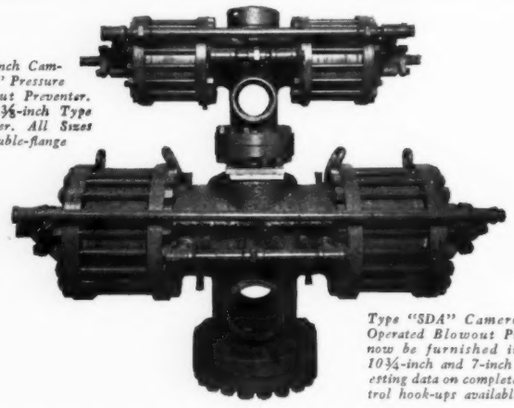
Darling Valve & Mfg. Co., Williamsport, Pa.; Drill Pipe & Casing Cutter Co., Los Angeles; Dunigan Tool & Supply Co., Breckenridge, Tex.

Eastman Oil Well Survey Co., Long Beach, Calif.; Ellison Draft Gauge Co., Chicago; Everlasting Valve Company, Jersey City, N. J.; Exner Dodge Packer Company, Coffeyville, Kans.

Failing, Geo. E., Supply Co., Enid, Okla.; Fischer, C. A., Company, Fort Worth, Tex.

Gardner-Denver Co. of Okla., Quincy, Ill.; Garlock Packing Company, Palmyra, N. Y.; Garrett Brass & Machine Co., Houston; Gas Power, Inc., Houston; Gatke Corp., Chicago; Gearench Mfg. Co., Houston; Girten Supply Company, Houston; Green Head Bit & Supply Co., Oklahoma City; Gulf Engineers, Inc., Houston; Gulf Envelope Co., Houston; Gulf Lubricator Co., Houston; Gulf Publishing Company, Houston; Gulf Tractor Equipment Co., Houston.

Halliburton Oil Well Cementing Co.,



Upper Unit: 7-inch Cameron Type "SDA" Pressure Operated Blowout Preventer. Lower Unit: 13⅜-inch Type "SDA" Preventer. All Sizes available in double-flange models also.

Type "SDA" Cameron Pressure Operated Blowout Preventers can now be furnished in 13⅜-inch, 10¾-inch and 7-inch sizes. Interesting data on complete drilling control hook-ups available on request.

CIRCULATION, ROTATION and SPUDDING of drill pipe

This is the new, Cameron Type "SDA" ram packing element, which is easily applied in field or shop without special tools. Contains a large, self-feeding reserve of resilient packing material which makes it entirely safe and practical to rotate and spud through closed preventer rams while maintaining a leak-proof seal against highest well pressures.

Type "SDA" preventer rams are specially machined to receive the Cameron one-piece ram packing element. They are also designed to center the pipe in the hole automatically.

. . . is practicable through closed rams of Type "SDA" Cameron Preventer

No practical well digger wants to have drill pipe in the hole standing still—even when he's fighting a kicking well. A threatened blowout is bad news, but stuck drill pipe is no picnic either. If your well is equipped with a Cameron Type "SDA" Pressure Operated Blowout Preventer, it can be shut-in swiftly and positively against any well pressure simply by opening a four-way valve. Moreover, while preventer rams are closed, drill pipe may safely be rotated and raised and lowered between tool joints while circulating to heavy-up the mud column. This freedom of action is made entirely safe and practicable by the new, self-feeding Cameron ram packing element. If you are not familiar with this remarkable development, full details will gladly be furnished on request.

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Duncan, Okla.; Hamer Oil Tool Company, Long Beach, Calif.; Harbison Fischer Co., Fort Worth, Tex.; Hercules Motors Corp., Canton, Ohio; Hill & Foster Company, Wichita Falls, Tex.; Holman, O. H., Co., Dallas; Horn, A. C. Co. of Texas, Houston; Hough, Chas. N., Mfg. Co., Franklin, Pa.

Independent Petroleum Association, Tulsa.

Johnston Formation Testing Co., Longview, Tex.; Jorgenson, Earle M., Company, Houston.

Kennedye Engineers, Houston; Kibele Mfg. Company, Dallas; Kinley, M. M., Co., Houston; Kinzbach Tool Company, Houston; Kobe, Inc., Huntington Park, Calif.; Koenig Iron Works, Houston.

Lamp Piston Sales Co., Torrance, Calif.; Locomotive Finished Material Co., Atchison, Kans.

McEvoy, J. H., & Co., Houston; Mechanical Equipment Co., Houston; Mepham, Geo. S., Corp., E. St. Louis, Ill.; Merchants Photo Service, Houston; Mid-Continent Supply Co., Fort Worth, Tex.; Mid-West Piping & Supply Co., St. Louis, Mo.; Mine Safety Appliance Co., Pittsburgh, Pa.; Minneapolis Moline Power Implement Co., Minneapolis, Minn.; Muller Co., Jno., Houston.

National Tube Co., Pittsburgh; Natural Gas Equipment Co., Los Angeles; Naylor Pipe Co., Chicago; Nicholson Steam Trap Co., Wilkes Barre, Pa.

The Oil and Gas Journal, Tulsa; Oil Center Tool Co., Houston; The Oil Weekly, Houston; Osage Metal Co., Inc., Oklahoma City; Oster-Williams Tool Co., Cleveland, Ohio; Otis Pressure Control, Inc., Dallas.

Patterson-Ballagh Corp., Los Angeles; Patton, H. L. Co., Houston; Petroleum Assn. of America, Tulsa; Petroleum Electric Power Club, Houston; The Petroleum Engineer, Dallas; Petroleum Service Bureau, Tulsa.

Realfire Burner Co., Tulsa; Red Rex Corp., Houston; Reda Pump Co., Bartlesville, Okla.; Regan Forge and Engineering Co., San Pedro, Calif.; Rice Institute, Houston; Rieber Instrument Co., Los Angeles; Rupley Brake Service, Houston; Ruska, Walter, & Co., Inc., Houston.

Service Pattern & Model Works, Houston; Shaffer Tool Works, Brea, Calif.; Spang, Chalfant & Co., Inc., St. Louis; Specialty Oil Tool Co., Los Angeles; Stone Oil Tool Co., Houston; Surface Combustion Co., Toledo, Ohio.

Texas Creosoting Co., Orange, Tex.; Texas Rubber & Specialty Co., Houston; Tips Engine Works, Austin, Tex.; Todd Sales Company, Rochester, N. Y.

U. S. Oil Tool Corp., Houston; Universal Rod & Equipment Co., Los Angeles; University of Texas, Austin.

Vernon Tool Co., Ltd., Los Angeles; Volz, G. W., Engineering Co., Long Beach, Calif.; Vortox Mfg. Co., Claremont, Calif.

Wagner Electric Corp., St. Louis; W-K-M Company, Houston; Webster Engineering Co., Tulsa; Well Equipment Co., Inc., Houston; Wessendorff-Nelms & Co., Houston; West American Rubber Company, Los Angeles; Westinghouse Pacific Air Brake Co., San Francisco; Wico Electric Co., Tulsa; Wilgus Regulator Co., Los Angeles; Wilson Mfg. Company, Wichita Falls, Tex.

Zink, John, Co., Tulsa.

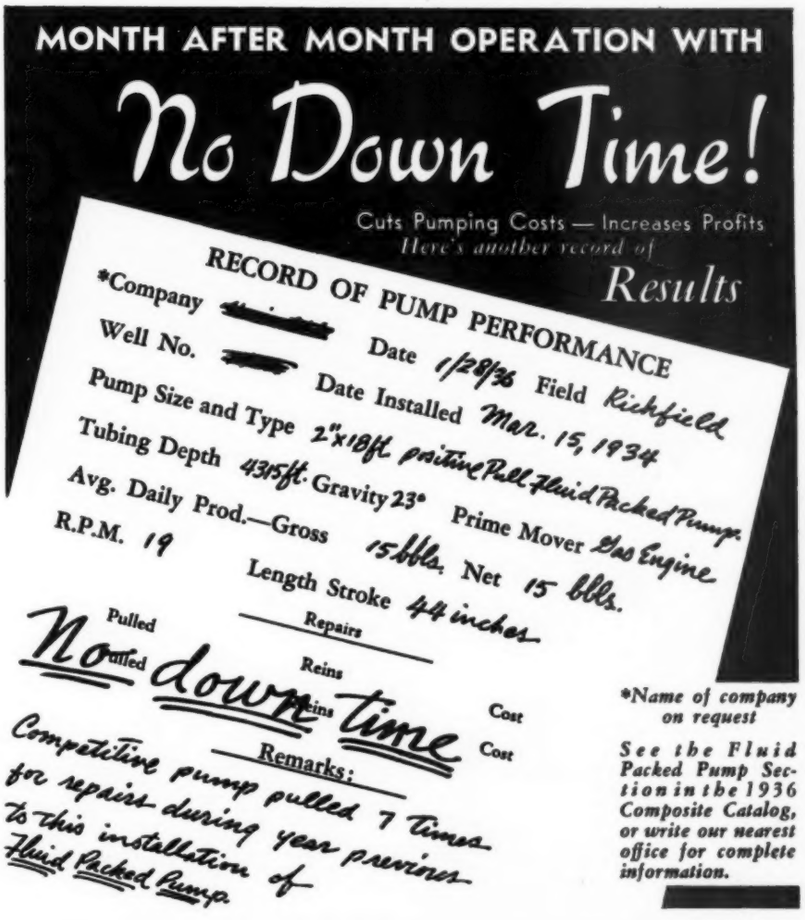
Semi-Annual Meeting A.S.M.E.

When the American Society of Mechanical Engineers holds its semi-annual meeting in Dallas June 15 to 20, inclusive, it will be the first time that organization has held a convention in the State of Texas. One of the principal reasons for having the meeting in Texas this year is the fact that the state's Centennial Exposition will be underway at that time.

Sessions will be held under the auspices of the various divisions of the society. There will be two sessions pertaining to the petroleum industry. Prof. W. H. Carson, of the University of Oklahoma and chairman of the Petroleum Division of the Society, is in charge of obtaining papers to be presented at those sessions. He is being assisted by Art Kerr, Tulsa, Oklahoma, district manager of the Equitable Meter Company.

REPRINTS OF DIRECTIONAL DRILLING SERIES AVAILABLE

Many readers of *The Petroleum Engineer* have written asking if the series of articles by Jas. D. Hughes on "Controlled Directional Well-Drilling and Surveying Practice," the concluding installment of which appears in this issue, would be available upon completion. We are glad to announce they can be obtained without cost by writing to Mr. Jas. D. Hughes, % Eastman Oil Well Survey Company of Texas, 4909 Fannin Street, Houston, Texas.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Lyons, Kansas, Phone 227

S. K. Burgess With Alford Sales and Service, Inc.

Appointment of S. K. Burgess as vice-president and assistant general manager of Alford Sales and Service, Ltd., of Long Beach, California, was announced recently by John A. Alford, president of the company.

"Mr. Burgess' connection with the oil industry dates back to 1907," Mr. Alford stated. "He is thoroughly experienced in all phases of production and sales work in connection with the manufacture of pumps and sucker rods. Mr. Burgess served as secretary-treasurer and a director of the D & B Pump and Supply Company until this company was purchased by the Emsco Derrick and Equipment Company.

"Increased business made the addition of executive assistance necessary and we consider ourselves fortunate in being able to acquire Mr. Burgess' services, as he is well known throughout the oil industry."

S. K. BURGESS

Twin Disc Clutch Company Opens Tulsa Office

The Twin Disc Clutch Company, Racine, Wisconsin, has opened an office in Tulsa, Oklahoma, at 310 East Fourth Street, in charge of John B. Jenkins, district manager. Sales for the states of Kansas, Oklahoma, and Texas are directed from this office. It also handles the service for the state of Oklahoma. This is a direct factory branch office that will materially improve Twin Disc contacts and service in the territory.

JOHN B. JENKINS

Annual Meeting National Stripper Well Association

Announcement has been made by H. B. Fell, executive vice-president of the National Stripper Well Association, at the national headquarters, 214 Thompson Building, Tulsa, Oklahoma, that the annual meeting of the association will be held at Tulsa on Friday, May 22, 1936, during the week of the International Petroleum Exposition.

It also was announced that William Bell, who has served as president of this association and who is now a member of the Interstate Oil Compact Commission representing the State of Illinois, will be present and preside at the annual meeting.

This association is composed of 18 oil and gas associations in nine oil-producing states, New York on the east to New Mexico on the west, and it is expected that there will be a large attendance of members of all these associations.

In addition to the regular business to be transacted at the meeting, Fell states there will be addresses on subjects of importance to the petroleum industry by stripper well operators who are leaders in their respective states.

Link-Belt Moves St. Louis Office

Announcement is made by Link-Belt Company that in order to handle increasing business they have moved their district sales office in St. Louis, Missouri, from 3638 Olive Street to 1018-21 Louderman Building, 317 North Eleventh Street. Larger quarters are thus provided in the heart of the St. Louis business district. Howard L. Purdon is district sales manager.

"Eddie" Goeser Passes On

The petroleum industry lost one of its best known members, and a man considered one of the foremost designers of oil well equipment, in the passing recently of Edwin W. Goeser, vice-president and production manager of Emsco Derrick and Equipment Company, at his home in Los Angeles. He had been in ill health for approximately a year.

EDWIN (Eddie) W. GOESER

Goeser was 53 years of age and had been an executive of the Emsco industries since 1923. He was born in Cincinnati, Ohio, was a graduate of Cincinnati Technical College, and moved to Los Angeles in 1905. He leaves his widow, Mrs. Florence M. Goeser; a daughter, Janet; his mother, Mrs. Emillie Goeser; and a sister, Miss Estelle F. Goeser.

Goeser's connection with the oil industry dates back to 1905, when he resigned his position as chief engineer for the R. H. LeBlond Machine Tool Company of Cincinnati to become chief engineer of the Union Tool Company, of Torrance, California. Later, when the ownership of the latter company was transferred to the National Supply Company of Toledo, Ohio, he was made chief engineer of all the manufacturing plants owned by that company, and was elected to the directorate of the Union Tool Company.

He severed his connections with the above companies in 1923 to become associated with E. M. Smith, being made executive vice-president of the Emsco Tool Company. When in 1926 that company was merged with the Emsco Steel Products Company to form the Emsco Derrick and Equipment Company, Goeser was made second vice-president and manager of production, which office he has filled since.

While it is not so widely known as his work in the heavy duty equipment field, Goeser developed one of the first electrical vacuum cleaners, which he sold to the Hoover Vacuum Cleaner Company in 1911. He is better known in the petroleum equipment field for having designed the first California built rotary machine, which embodied outstanding improvement in its enlarged design and construction. Heavy-duty drilling equipment and the evolutionary trend in rotary drilling machinery since rotary machines were first tried in California, were among the developments with which he was actively identified. Perhaps his greatest accomplishment was the designing of the Emsco drawworks, one of the largest ever built.

Funeral services were conducted at the Little Church of the Flowers in Forest Lawn Memorial Park, Glendale, California, on January 23rd, and the remains were entombed in Forest Lawn Mausoleum. D. S. Faulkner, W. A. Trout, J. S. A. Smith, H. C. Morehouse, E. D. Davidson, and L. R. McCollum, all of whom were intimate friends and co-officers in his various companies, officiated as pallbearers.

SCRAP... or USABLE?

Piles of scrap are a familiar sight to many oil men . . . because muck-covered valves, pipe, chain, meters, unions and other miscellaneous parts have a way of accumulating only too rapidly!

The question arises . . . do you treat this as just junk? Or do you clean such equipment and parts thoroughly and then inspect to see what is still usable?

Salvaged Over $40,000.00 Worth of Equipment

One company has found that with low-cost Oakite cleaning it has been able to salvage more than $40,000.00 of equipment! Parts reclaimed either go back in stock or are repaired if necessary, and put into service again.

Salvaging parts and equipment is easy and inexpensive when you use Oakite cleaning methods and materials. And not only are they thorough and efficient but also SAFE . . . there is NO fire hazard!

Let us give you further data on how you can get profits out of your scrap pile and save money. Write today . . . there is no obligation.

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SPECIALIZED INDUSTRIAL CLEANING MATERIALS & METHODS

Trade Personals

G. M. AKIN has recently joined the sales staff of the Mid-Continent Supply Company, Mid-Continent Building, Fort Worth, Texas. He will cover the East Texas field and will have his headquarters at the company's Kilgore store.

H. H. BROWN also has been added to the Mid-Continent's sales staff. His territory will be West Texas and New Mexico, with headquarters at Hobbs, New Mexico.

HENRY SHAW, representing the Reed Roller Bit Company, Houston, in the West Texas district, with headquarters at Midland, has been transferred to the Wichita Falls district and will make his headquarters in that city. **S. P. HAZLIP,** who has been at Wichita Falls, has been moved to Midland.

COL. W. F. ROCKWELL, president of the Merco Nordstrom Valve Company, with headquarters at Pittsburgh, Pennsylvania, made a business trip recently to the Mid-Continent and California. **ART KERR,** Tulsa, Mid-Continent manager for the company, accompanied Colonel Rockwell to Dallas.

G. J. GOODSON has been appointed Mid-Continent manager for the Bradford Motor Works, of Bradford, Pennsylvania. His headquarters are in Tulsa, Oklahoma.

F. K. TAYLOR, vice-president in charge of industrial sales, Taylor Instrument Companies, Rochester, New York, is on a tour of the Mid-Continent and Pacific Coast offices of the company. He will return to Rochester about March 1st.

L. D. HILTON, sales manager of the Cameron Iron Works Company, Houston, Texas, has returned to headquarters following a trip through California, Wyoming, Colorado, Oklahoma, and Louisiana fields.

R. V. EVRIDGE, long connected with the oil industry, having been with such companies as the Sinclair Oil and Gas Company; Mike Delaney, independent operator, and the Josey Petroleum Company, recently took a joint position with the Davidson Drilling Company and the Rector Well Equipment Company, Inc., Fort Worth, Texas. These two organizations have moved their offices to 1601-3 Fort Worth National Bank Building.

JOHN DILLON, of the Titusville Iron Works, Titusville, Pennsylvania, recently made a brief business trip to California.

T. K. MIAL, vice-president of the Johns-Manville Sales Corporation and general manager of the Power Products Industrial Department, has announced the appointment of **GEORGE DANDROW** as manager of the New York district of that department, with offices at 22 East Fortieth Street, New York City.

NEIL CURRIE, JR., for the last six years manager of the General Electric Company's Philadelphia Works, was made manager of its Fort Wayne Works effective February 1st, it was announced recently by **W. R. BURROWS,** vice-president in charge of manufacturing. Currie succeeds **WALTER S. GOLL** who, although retiring as manager after 38 years of service, will continue with the company and will be available for special assignments. **R. V. GOOD,** previously assistant manager at Philadelphia, was appointed manager to succeed Currie.

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We've Got It.
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Our new loans in 1935 averaged nearly two million dollars per month. We want to do even better in 1936. Of course you know . . that this bank's services are outstanding; that it is particularly able to do business with the oil industry; and that it is the logical place for you to borrow money.

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SOON PAYS FOR ITSELF WITH SAVINGS!

SAND and shale in drilling mud shorten the life of pump, valve and swivel parts and do other damage that costs real money. The *surest* way to avoid this expense is to clean your mud with the McNEELY Vibrating Mud Screen—used by operators the world over for its efficiency and economy. Advanced mechanical features, such as twice the average screen cloth life, further contribute to savings.

Get complete details from your Supply House or write for Catalog.

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Gulf Coast and Mid-Continent Representative
BAROID SALES CO., HOUSTON

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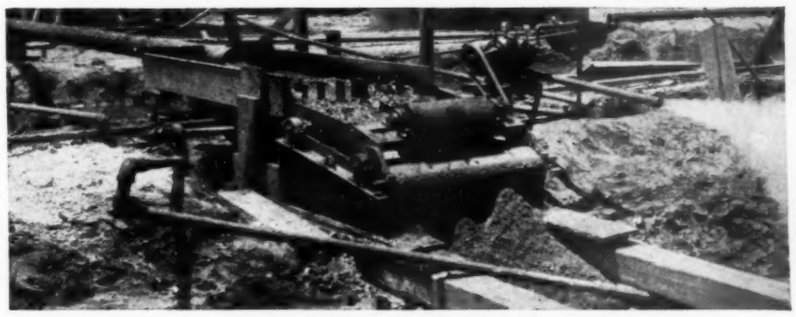
The National Supply Corp. - Oil Well Supply Co.



Money-saving McNEELY Vibrating Mud Screen maintaining a clean drilling fluid at Odessa, Texas.

The McNEELY Vibrating MUD SCREEN

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HOTEL LASSEN
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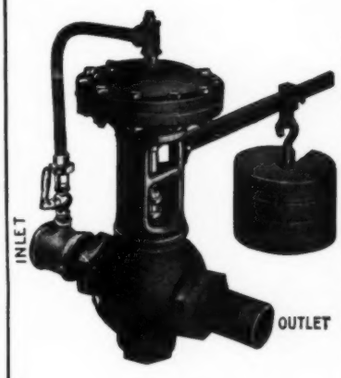
Keeps Discharge Constant--- Full-Speed Operation Safe



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Compressor Regulator

As a close regulator of pressure on constant-speed pumps, the C-F Compressor Regulator has no equal. Thoroughly dependable in all applications where such a device is needed. Excess discharge pressure flows through and is relieved with no appreciable variation in the suction line. Lever-type regulator is here shown. Spring-loaded type is also available and is equally sure-working.

Ask for Bulletin No. 130, also for catalog of Chaplin-Fulton Regulators.

THE CHAPLIN-FULTON MFG. CO.
28-40 PENN AVENUE PITTSBURGH, PA.

I.P.A.A. Mid-Year Meeting to Be Held May 21

At the national headquarters of the Independent Petroleum Association of America, 214 Thompson Building, Tulsa, Oklahoma, it has been announced by C. E. Buchner, executive manager, that the mid-year meeting of the association will be held at Tulsa, Oklahoma, on Thursday, May 21, 1936, during the International Petroleum Exposition.

Buchner stated that the mid-year meeting was to be held at Tulsa at the time indicated in order that the directors and members of the association might have an opportunity to attend the mid-year meeting and the International Petroleum Exposition at the same time.

It was announced that the final program for the meeting had not been determined upon, but would be finally worked out and approved at the next meeting of the executive committee. Buchner also stated that it was probable the program would consist of a short membership meeting, a meeting of the board of directors, and a banquet in the evening.

Pacific Coast District A. P. I. Spring Meeting April 14

The Pacific Coast District of the Division of Production of the American Petroleum Institute will hold its annual spring meeting in Los Angeles on Tuesday, April 14th, it is announced by Bruce Barkis, of the Rio Grande Oil Company, district chairman.

Two technical sessions will be held, the morning session being devoted to production practice, and the afternoon session to drilling practice. The chairman of the program committee, W. C. Whaley, of the Barnsdall Oil Company, is interested in obtaining technical papers to be presented at these group meetings and will welcome suggestions.

The annual banquet will be held in the evening as usual, but it is not planned to present any technical papers at this time.

Further plans will be announced later.

National Metal Congress and Exposition to Be in Cleveland

The 1936 National Metal Congress and Exposition, to be held in Cleveland's Public Auditorium, will be staged October 19th to 23rd, inclusive. Announcement was made by W. H. Eisenman, managing director of the exposition and national secretary of the American Society for Metals, which annually sponsors this event.

"This gives Cleveland one of the year's largest industrial shows," Eisenman said. "Thirty-five thousand engineers, metallurgists, and practical men in the metal industry visited last year's exposition, which included the latest developments in metals and their use. Two hundred exhibitors used 175,000 sq. ft. of floor space to exhibit their products."

Five technical societies coöperate to stage this annual event. They are the American Welding Society, the Wire Association, the Institute of Metals, and Iron and Steel divisions of the American Institute of Mining and Metallurgical Engineers, and the American Society for Metals.

The annual conventions of these societies will be held at this time and will attract a large percentage of the total membership, which is close to 20,000.

Because . . .

COOK'S Piston Rings

reduce cylinder wear . . .

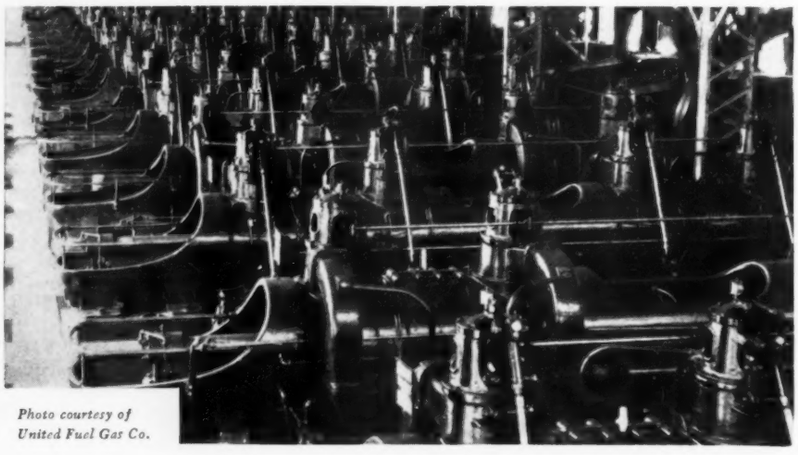

Photo courtesy of United Fuel Gas Co.

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NATURAL GAS INDUSTRY

The selection of COOK'S GRAPHITIC IRON Piston Rings by a great majority of the prominent operators of Natural Gas pumping engines, adds further evidence of the widespread recognition of COOK'S Rings' superiority. They predominate because of the operating economies they effect — reduced cylinder wear — added years of engine life — fewer shutdowns for repairs. You, too, can obtain these economies by specifying COOK'S Rings on your next order.

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W. H. Correa and Elizabeth Baird Bope Married

Elizabeth Baird Bope, of Detroit, and William H. Correa, vice-president of the Standard Oil Company of New York and an official of the Socony-Vacuum Oil Company, Inc., were married recently at the First Presbyterian Church, on Fifth Avenue. The ceremony was performed by Dr. J. V. Moldenhawer. Mrs. Correa's matron of honor was Mrs. Hamilton Cross, of Ridgewood, New Jersey, and Miss Betsy Bope, daughter of Mrs. Correa, was her bridesmaid. Mr. William Correa, Jr., was best man.

Mrs. Correa is the daughter of the late Hugh Baird, who was consulting engineer for the United States Steel Corporation. She was formerly married to Harold Bope, son of the late Colonel Henry Bope, a Pittsburgh steel man.

Following a honeymoon in Florida, Mr. and Mrs. Correa will reside at No. 1 Lexington Avenue.

Drilling to Start at Kuwait, Persian Gulf

Following extensive geological studies, several sites for test drilling have been selected north and south of Kuwait Bay, Arabia, by the Kuwait Oil Company, Ltd., and operations on the first well will start almost immediately. This company was organized in Great Britain in 1934, jointly by the Anglo-Iranian Oil Company, Ltd., of London, and by the Gulf Exploration Company of Pittsburgh, Pennsylvania, the latter being a subsidiary of the Gulf Oil Corporation.

After No. 1 well is completed a second well will be spudded-in at a location south of Kuwait.

A combination rig, with complete rotary and cable drilling equipment, has been shipped to the Persian Gulf, the power for which will be furnished by Waukesha gasoline engines. The drilling sites are within ten miles of seaboard. If necessary, drilling will be to 6000 ft. L. G. Scott, of the Anglo-Iranian Oil Company, will be in charge as general field superintendent of the Kuwait Oil Company, and T. H. Rakestraw, of the Gulf Production Company, will be the drilling superintendent.

Domestic Asphalt Committee of I.P.A.A. Named

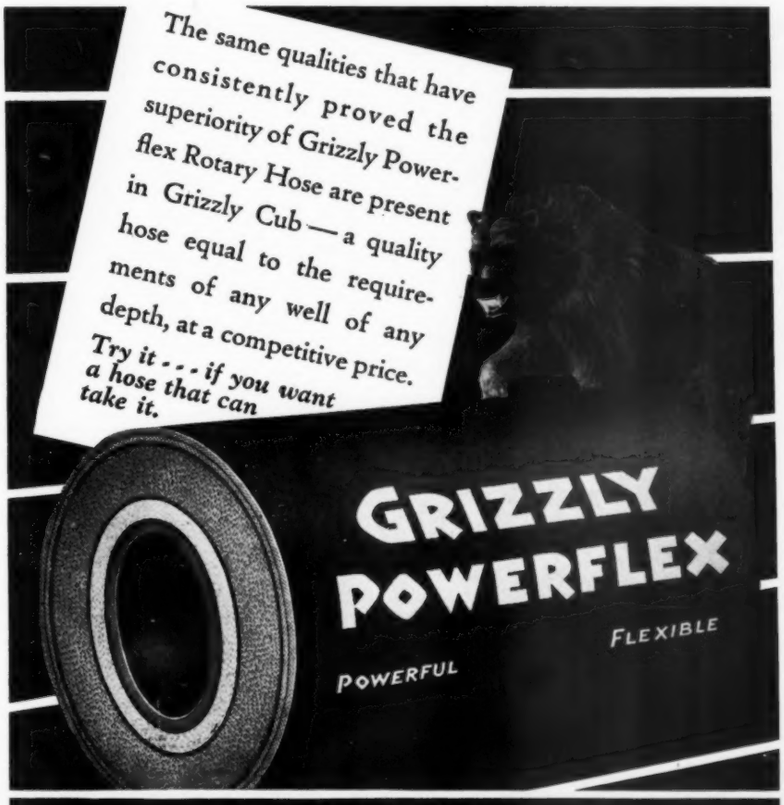
Announcement is made by H. B. Fell, executive vice-president of the Independent Petroleum Association of America, that C. F. Roeser, president of the association, has appointed as members of the Domestic Asphalt Committee of the association for the ensuing year the following: L. H. Prichard, Oklahoma City, Oklahoma, chairman; T. M. Martin, El Dorado, Arkansas; J. K. Mahony, El Dorado, Arkansas; Emby Kaye, Tulsa, Oklahoma; L. E. Kincannon, Duncan, Oklahoma; Paul G. Blazer, Ashland, Kentucky; J. B. Arthur, Los Angeles, California; J. L. Quinn, New York, New York; E. C. Moriarty, Wichita, Kansas, and L. P. Calkin, Bartlesville, Oklahoma.

All members of this committee are representatives of companies engaged in the manufacture of asphalt and road oils in the United States from crude oil produced in the United States. Four members of this committee were members of the Domestic Asphalt Committee of the Independent Petroleum Association of America the past year.

A HOSE THAT CAN

Take it . .

AT A COMPETITIVE PRICE


The same qualities that have consistently proved the superiority of Grizzly Powerflex Rotary Hose are present in Grizzly Cub — a quality hose equal to the requirements of any well of any depth, at a competitive price.
Try it - - - if you want a hose that can take it.
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Much New Equipment to Be on Display at International Petroleum Exposition

An estimated 10,000 changes, improvements, and entirely new devices have been made and perfected in the oil industry the past two years, and these will be on display at the ninth International Petroleum Exposition in Tulsa May 16 to 23, according to W. A. Schlueter, chairman of the scientific and technical committee.

"With several months ahead the exhibitor list alone (on January 22) represents more than 500 manufacturers in 123 cities and 26 states of the Union," said Schlueter. "Added to these will be scientific displays being arranged by a committee of more than 20 experts in the prospecting, producing, refining, transportation, and marketing divisions of the industry.

"No one individual could cover 123 cities and 26 states and see 500 manufacturers in a week. Yet the International Petroleum Exposition gives him this opportunity, for it brings these 500 manufacturers to one locality, where he may not only see them but have their products side by side for comparison."

Meetings to be held in Tulsa in conjunction with the exposition already have been set by the American Petroleum Institute (spring meeting); Natural Gasoline Association of America, and National Stripper Well Association. The exposition is in contact with a number of others and at least 15 more are expected to hold some kind of a meeting. At previous expositions between 15 and 25 oil associations have met in Tulsa.

Another meeting planned is the First-Aid Safety Conference and Demonstration. Companies entering teams at the 1934 exposition and which are to enter teams this year include: Humble Oil and Refining Company, Shell Petroleum Corporation, Continental Oil Company, the three winners of 1934; and Barnsdall Oil Company, Empire Oil and Gas Company, Empire Pipe Line Company, Phillips Petroleum Company, Marathon Oil Company, Sinclair-Prairie Oil Company, White Eagle Oil and Refining Company, Dewey Portland Cement Company, Ohio Oil Company, Kanotex Refining Company, Oklahoma Natural Gas Company, and Tide Water Oil Company.

The committee is composed of G. O. Lockwood, The Empire Companies; Jack Savage, Mid-Continent Petroleum Company; D. J. Wallace, Sinclair Prairie Oil Company; R. S. Huffman, Oklahoma Natural Gas Company; Kraus Earhart, The Texas Company; Tom Lyttle, The Empire Companies, and H. T. Markee, Phillips Petroleum Company.

TRADE LITERATURE

DIRECTIONAL DRILLING SERIES IN BOOKLET form free. The very popular series on "Controlled Directional Well-Drilling and Surveying Practice," by Jas. D. Hughes, which has been appearing monthly in *The Petroleum Engineer*, is now available in booklet form and without cost to anyone interested. Write to Mr. Hughes, care Eastman Oil Well Survey Company of Texas, 4909 Fannin Street, Houston, Texas.

THE KEROTEST MANUFACTURING COMPANY has issued its new catalog, No. 36, which completely describes the line of Kerotest products for the oil industry. Copies of the publication will be sent free upon request to the manufacturer: The Kerotest Manufacturing Company, 2525 Liberty Avenue, Pittsburgh, Pennsylvania.

To Handle Parkersburg Tanks

The Parkersburg Rig and Reel Company recently completed arrangements with the Harvey Tank and Equipment Company of Cut Bank, Montana, whereby the latter will distribute Parkersburg bolted tanks in Colorado, Wyoming, and Montana.

Annual Sales Conference Parkersburg Rig and Reel Company

The accompanying photograph was taken at the time of the Thirteenth Annual Sales Conference of the Parkersburg Rig and Reel Company, recently held at Parkersburg, West Virginia. In the photograph are: John M. Crawford, chairman; David J. Crawford, president; C. A. Ruf, vice-president; B. M. Farson, secretary; P. L. Brooks, sales manager; D. H. Wolfe, director of purchases; William Schwemlein, chief engineer; H. D. Crawford, eastern district manager; V. E. Milsark, traffic manager; J. F. Townshend, credit manager; A. H. Fisher, foundry superintendent; J. A. Thomas, district manager export division; L. R. McCollum, district manager Los Angeles; J. E. Dever, Mt. Pleasant, Michigan—Tri-State district: S. P. Wallace, district manager, Dallas; H. A. Miller, Shreveport; T. J. Costello, Dallas; J. M. Baldridge, Tyler; O. Brechtel, Dallas; J. E. Hobson, Odessa; H. C. Coats, Willow Springs—Gulf Coast district: V. E. Ashford, district manager, Houston, Texas; J. A. Lyne, Houston; E. M. Fontaine, Houston; L. G. Rader, Lake Charles, Louisiana; L. V. Gibson, Corpus Christi—Kansas-Oklahoma district: H. L. Dickson, district manager, Tulsa; E. L. Byer, assistant district manager, Tulsa; C. C. Witt, Tulsa; Charles Ferguson, Oklahoma City; L. W. Whetstone, Ada; E. E. McDonald, Great Bend, Kansas; Karl H. Kanalz, Tulsa—Parkersburg office: R. G. De La Mater; L. A. Allen; C. H. Cutlip; J. W. Root; H. L. Ruf; E. K. Ahrendt; F. E. Mason; B. Ward; B. H. Eells.

Waukesha Motor Appoints De Long General Manager

James E. De Long, executive vice-president of Waukesha Motor Company, Waukesha, Wisconsin, has been appointed general manager of that organization. De Long has been connected with the Waukesha Motor Company for 13 years, having joined the organization in 1923 as field engineer in charge of oil industry operations.

JAMES E. DE LONG

He also will continue as head of the executive board, established in 1928 by the late Harry L. Horning. Other members of the board include J. B. Fisher, chief engineer; C. P. Ross, assistant secretary and treasurer; J. G. Swain, sales manager, and A. S. Cronk, director of purchases. Originally established as part of Waukesha Motor Company's broad organization program, this board continues to function in the capacity of a supervisional committee on all productive and marketing operations. All members are on the board of directors.

New Houston Plant Cavins Bailer Service Company

Shown here is the new service headquarters at Houston of the Cavins Bailer Service Company of Texas, organized three years ago by Tom Sharp, general manager. The plant,

recently completed, is on the Beaumont road. In the picture, reading left to right, are: Baker Shannon, South Texas district manager; Tom Sharp, general manager; K. B. Knox, Gulf Coast representative; J. B. Tucker, service manager; and John Pen Gelly, shop service manager. In addition, the Cavins Bailer Service Company of Texas has the following district managers: H. L. Waters, Kilgore, covering East Texas fields; Elmer Glover, Odessa, in charge of West Texas and New Mexico fields; and M. A. Widmayer, El Dorado, Arkansas.

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TO MEET OPERATING CONDITIONS

5 SPECIALIZED Balls & Seats

Engineered to meet all normal operating conditions and available at good supply stores:

B-M-W MONARCH — For extra severe service. Harder than other non-corrosive balls and seats. Stands up under the cutting action of sand—no ball breakage.

B-M-W EXTRARD BRONZE — Extremely hard bronze alloy—will perform where lodestone and corrosive elements are present.

B-M-W BI-METAL—Chromard Seat and Extrard Bronze Ball — for use where lodestone and floating sand are present.

B-M-W CHROMARD — Stainless Steel — non-corrosive—stands up under cutting action of floating sand.

B-M-W BRAMO—General purpose ball and seat — high grade tool steel — moderate in price.

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OIL WELL SUPPLIES
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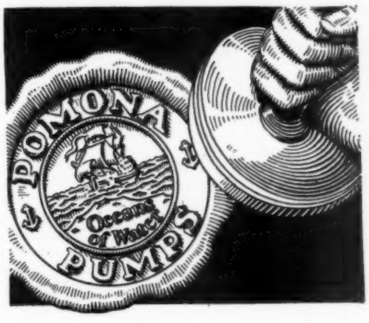
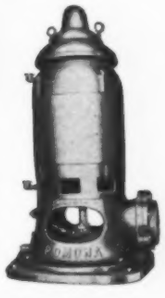
EXPORT OFFICE, 30 CHURCH ST., NEW YORK CITY



THE MARK OF MODERN PUMPING



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Pomona is the mark of modern pumping because Pomona Pumps meet modern requirements. Located at the heart of the pioneer irrigation district, Pomona engineers have had long experience in solving the problem of getting large volumes of water out of the ground at the lowest cost. In this they have succeeded so well that Pomona Pumps have been demanded by mines and municipalities, by industrial plants, country clubs and private estates, and by every type of industry in which a self-controlled supply of water is desired.

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POMONA TURBINE PUMPS

WANTED—Mechanical Engineer, preferably 30 to 40 years old, experienced in oil field drilling and production, or equipment manufacture. To locate in Western Pennsylvania. Submit complete personal data and salary expected. Address Box 201, care *The Petroleum Engineer*, 406 Tower Petroleum Bldg., Dallas, Texas.

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HOUSTON, TEXAS. TULSA, OKLAHOMA
AND LONG BEACH, CALIFORNIA
SURWEL (Gyroscopic) **H-K** (Open Hole) **SYFO** (Ink Bottle)
UNDERGROUND WELL SURVEYING SERVICE

A. L. Weil Heads California Oil and Gas Association

A. L. WEIL

A. L. Weil, president of the General Petroleum Corporation of California, has been elected head of the California Oil and Gas Association. He succeeds Charles S. Jones, president of the Rio Grande Oil Company, who has been president of the association the last two years.

Ralph B. Lloyd, president of the Lloyd Corporation, was named first vice-president, L. P. St. Clair, president of the Union Oil Company, second vice-president, and H. L. Westbrook, of the Belridge Oil Company, continues as treasurer. Col. F. E. Foster, managing director, and D. S. Kilgour, assistant manager, retain their respective posts.

Directors for 1936 are: S. Belither, Shell Oil Company; R. A. Broomfield, Barnsdall Oil Company; R. E. Collom, Continental Oil Company; J. A. Crawford, Republic Supply Company; Emil Ducommun, Ducommun Corporation; E. S. Dulin, Byron Jackson Company; E. B. Gilmore, Gilmore Oil Company; Oscar R. Howard, financier; William F. Humphrey, Associated Oil Company; C. S. Jones, Rio Grande Oil Company; K. R. Kingbury, Standard Oil Company of California; W. H. Reid, Hancock Oil Company; W. C. McDuffie, Richfield Oil Company; Alexander B. Macbeth, Southern California Gas Company; A. C. Mettei, Honolulu Oil Corporation; A. W. Taylor, Western Oil Company; C. E. Olmstead, The Texas Company; William Reinhardt, Kettleman North Dome Association; and F. C. Ripley, Chanslor-Canfield Midway Oil Company.

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HOUSTON'S NEWEST
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Convenient to all business activity.
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South's finest grill for good food and quick service; and mezzanine diningroom, with charming atmosphere.
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Houston's finest theatres only one to three blocks away.
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Seventeen stories of fresh air and sunshine, every room with tub and shower.
$2.50 up
IN THE HEART OF HOUSTON
B.F. ORR, MANAGER
FAMOUS GRILL
Features Wonderful Food

Dewey T. Ross, Incorporated, Announces Expansion Program

Dewey T. Ross, president of the construction engineering organization in Tyler, Texas, bearing his name, announces a recent expansion program that broadens the scope of the corporation's work and increases the personnel. Henry L. Lemons, former Tulsa pipe line contractor, has become associated with Dewey T. Ross, Inc., following the recent entry of the organization into pipe line contracting. Courtney & Peterson, engineers of Lake Charles, Louisiana, have been appointed as agents in Louisiana for Ross' organization.

Appointed District Representatives

Robbins & Robbins, 504 Howard Avenue, New Orleans, Louisiana, have been appointed district representatives by Struthers-Wells Company, Warren, Pennsylvania, manufacturers and engineers of steel and alloy steel equipment.

Robbins & Robbins will cover the states of Louisiana and Mississippi.

Name 1936 Officers for American Petroleum Industries Committee

Colonel Harry T. Klein, of New York City, vice-president of The Texas Company, has been re-elected chairman of the American Petroleum Industries Committee for a third term, it has been announced.

Edwin S. Hall, counsel for Standard Oil Company of New Jersey, was re-elected secretary, and Baird H. Markham, director of the committee, was re-appointed to that post, which he has held since the formation of the committee in 1933.

The committee created the office of assistant secretary, and Herbert Galloway, formerly of the Continental Oil Company, Ponca City, Oklahoma, was appointed to that position. Prior to his work in the comptroller's office of Continental Oil Company, Galloway was employed by Harris & Haun, independent producers of crude oil and natural gasoline, in Blackwell, Oklahoma.

Director Markham reported that branches of the American Petroleum Industries Committee have been established in 46 of the 48 states, and local committees are in operation in 948 counties.

The committee was organized in 1933 to aid gasoline tax administrators in the strengthening of state gasoline tax laws, to eliminate gasoline tax evasion, and to act as a service organization to the oil industry in connection with tax and legislative matters.

The S. M. Jones Company Announces Personnel Changes

As a result of the demand from oil companies for factual information on pumping conditions and sucker rod selection, the S. M. Jones Company, Tulsa, Oklahoma, announces personnel changes, effective February 1st. C. E. Buchner, Jr., is transferred from the field engineering department to the Houston division office, where he will act as sales engineer under direction of L. J. Pundt, division manager. Buchner is a graduate in petroleum engineering from the University of Tulsa and has had two years' experience in the engineering department of one of the large oil companies, in addition to his more recent efforts with the S. M. Jones Company. He has had a wide experience in pumping conditions effecting sucker rods, having been responsible for many well studies compiled in the field engineering department of the S. M. Jones Company.

C. E. BUCHNER, JR.

The announcement is also made of the employment of W. F. Slater, who will be attached to the field engineering department. Slater studied petroleum engineering at Oklahoma University and also has had two years' experience in field pumping conditions.

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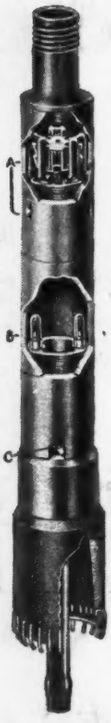

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